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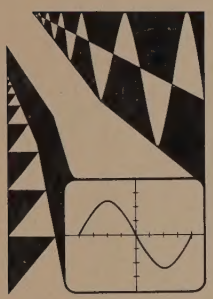

15 MHz Oscilloscope

PM 3225/··

9499 440 16702

770201

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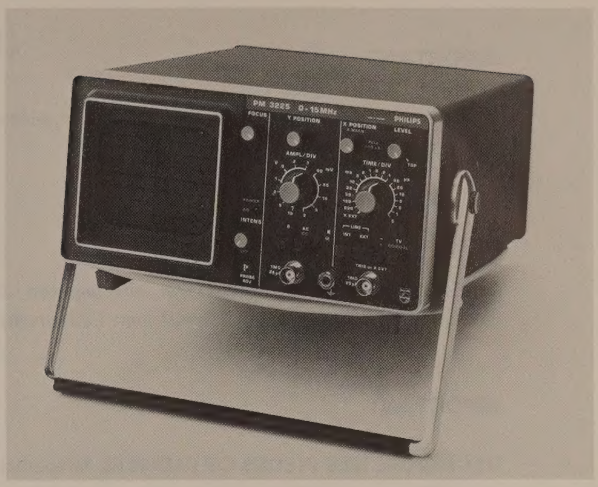

Instruction manual
Gerätehandbuch
Notice d'emploi et d'entretien

15 MHz Oscilloscope
15-MHz-Oszilloskop
Oscilloscope de 15 MHz

PM 3225/··

9499 440 16702

770201

IMPORTANT

In correspondence concerning this intrument, please quote the type number and serial number as given on the type plate.

WICHTIG

Bei Schriftwechsel über dieses Grät wird gebeten, die genaue Typenbezeichnung und die Gerätenummer anzugeben. Diese befinden sich auf dem Leistungsschild.

IMPORTANT

RECHANGE DES PIECES DETACHEES (Réparations)

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez TOUJOURS indiquer le numéro de série qui sont marqués sur la plaquette de caractéristiques.

NOTE: *The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.*

BEMERKUNG: *Die Konstruktion und Schaltung dieses Geräts wird ständig weiterentwickelt und verbessert. Deswegen kann dieses Gerät von den in dieser Anleitung stehenden Angaben abweichen.*

REMARQUES: *Cet appareil est l'objet de développements et améliorations continuels. En conséquence, certains détails mineurs peuvent différer des informations données dans la présente notice d'emploi et d'entretien.*

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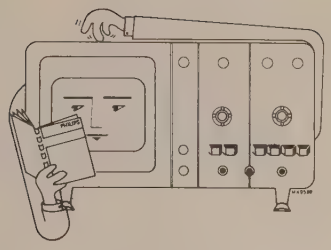
Operating manual

1. General information



1.1 INTRODUCTION

The 15 MHz Portable Oscilloscope PM 3225 is a compact, lightweight instrument featuring simplicity of operation, for a wide range of use in servicing, research and educational applications.

Other features include automatic triggering in addition to mains triggering and triggering on the line and frame sync pulses of a television signal.

The cathode-ray tube displays a useful screen area calibrated into 8 x 10 divisions by an external graticule.

All circuits are fully transistorized and mounted on printed-circuit boards for ease of maintenance.

The straight-forward design and layout combines simple operation with a high degree of reliability.

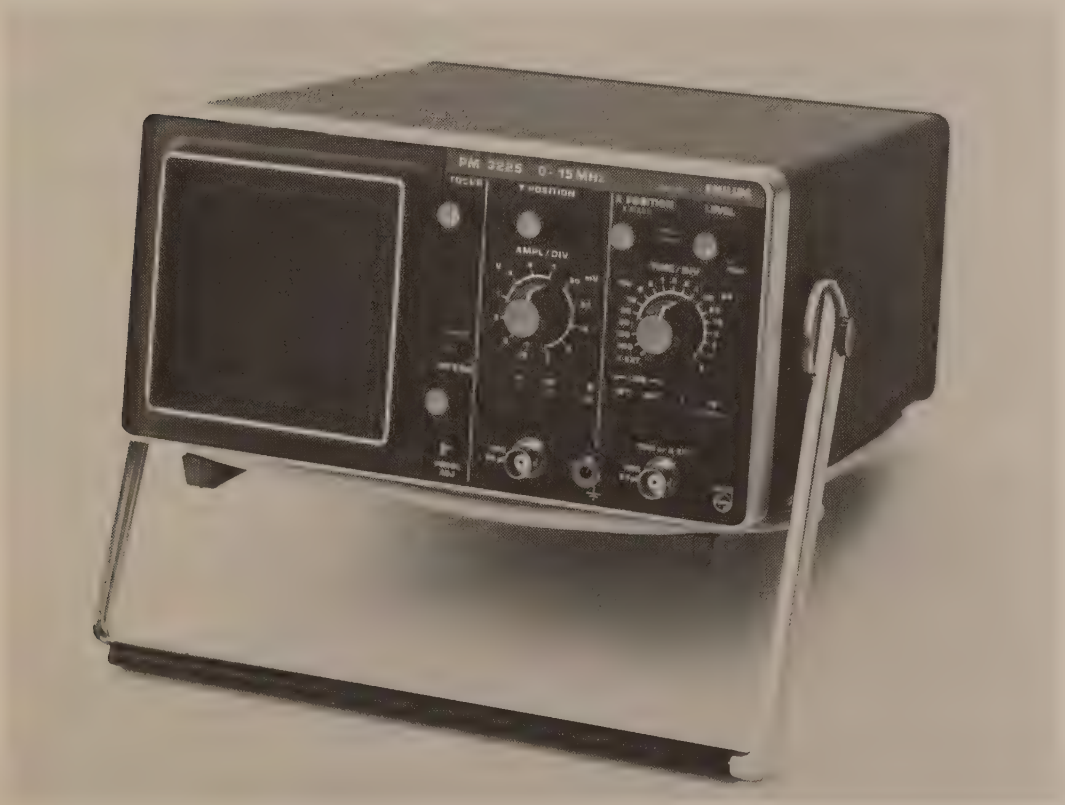


Fig. 1.1. Front view PM 3225

1.2 TECHNICAL DATA

General Instructions

Only properties expressed in numerical values, with tolerances stated, are guaranteed by the factory. Numerical values without tolerances are typical characteristics of an average instrument only.

Designation	*Specification*
1.2.1 Cathode-ray tube	
Type	: D10 – 160 GH
Measuring area	: 8 x 10 divisions of 7.5 mm
Screen type	: P31 (GH) P7 (GM) optional
Acceleration voltage	: 1.5 kV
Graticule	: External, non-illuminated
1.2.2 Vertical amplifier	
Frequency range	: d.c. 0 Hz to 15 MHz : a.c. 2 Hz to 15 MHz
Risetime	: 25 ns
Overshoot	: ⩽ 3 % (test pulse: 6 div. amplitude, 3 ns risetime)
Deflection coefficients	: 2 mV/div. to 10 V/div. in twelve calibrated steps in 1-2-5 sequence; accuracy ± 3 %.
Maximum permissible input voltage	: ± 400 V (d.c. + a.c. peak) Resistant against non-repetitive surges of up to 1000 V
Vertical position range	: 16 divisions
Dynamic range	: 24 div. for sinewave signals with frequencies of up to 1 MHz 6 div. for sinewave signals of up to 15 MHz
Input impedance	: 1 MOhm // 25 pF
1.2.3 Horizontal amplifier	
Response	: d.c. up to 100 kHz
Deflection coefficients	: 5 V/div. at x1 magnifications accuracy ± 15 % : 1 V/div. at x5 magnification
Maximum permissible input voltage	: ± 400 V (d.c. + a.c. peak). Resistant against non-repetitive surges of up to 1000 V
Input impedance	: 1 MOhm // 25 pF
Phase shift	: 5° at 50 kHz
1.2.4 Timebase	
Time coefficients	: 0.2 sec/div to 0.5 µsec/div in 18 calibrated steps in 1-2-5 sequence
Coefficient error	: ± 5 %
Expansion	: x5, 1 calibrated step
Additional error	: 2 %
1.2.5 Triggering	
Sources	: Internal : External : Line

Designation		*Specification*
Trigger sensitivity	:	Internal; level — ⩽ 0.75 div. at 100 kHz 1,5 div. at 15 MHz top — ⩽ 2 div. at 15 MHz TV — 0.5 div. for line or frame sync pulses External; level — 0.75 V at 100 kHz 1,5 V at 15 MHz top — ⩽ 2 V at 15 MHz TV — 0.5 V for line or frame sync pulses
Input impedance	:	1 Mohm // 25 pF
Maximum permissible input voltage	:	± 400 V (d.c. + a.c. peak). Resistant against non-repetitive surges of up to 1000 V.
Trigger mode	:	Timebase generator runs free in absence of trigger signal. a. Trigger level adjustable over 12 div. or 12 V. Lowest triggerable frequency for sinewaves = 10 Hz. b. Top.
Trigger slope	:	+ or —
Triggering with TV signals	:	Frame (coupled with positions .5 ms/div to 200 ms/div) Line (coupled with positions .2 ms/div to .5 µs/div)
Probe adjustment	:	Contact point (for conditions see Section 2.2.3)

1.2.6 Environmental characteristics

The TECHNICAL DATA are valid only if the instrument is checked in accordance with the official checking procedures. Details on these procedures and failure criteria are supplied on request by the PHILIPS Organization in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST & MEASURING DEPARTMENT, EINDHOVEN, THE NETHERLANDS.

1.2.6.1 Temperature

— Reference value	:	23 deg C
— nominal operating temperature range	:	+ 5 deg C to + 40 deg C
— operating temperature range limits	:	— 10 deg C and + 55 deg C
— temperature range for storage and transport	:	— 40 deg C to + 70 deg C

1.2.6.2 Altitude

Limit range of operation	:	5000 m } in open air
Limit range of transport	:	15000 m } in open air

1.2.6.3 Humidity

Meets IEC 60 Db requirements

1.2.6.4 Bump

1000 bumps of 10 g, ½ sine, 6 ms duration, in each of 3 directions.

1.2.6.5 Vibration

30 minutes in each of three directions, 10-150 Hz; 0.7 mm p-p and 5 g max. acceleration.

1.2.6.6 Electromagnetic interference

Meets VDE, Störgrad K.

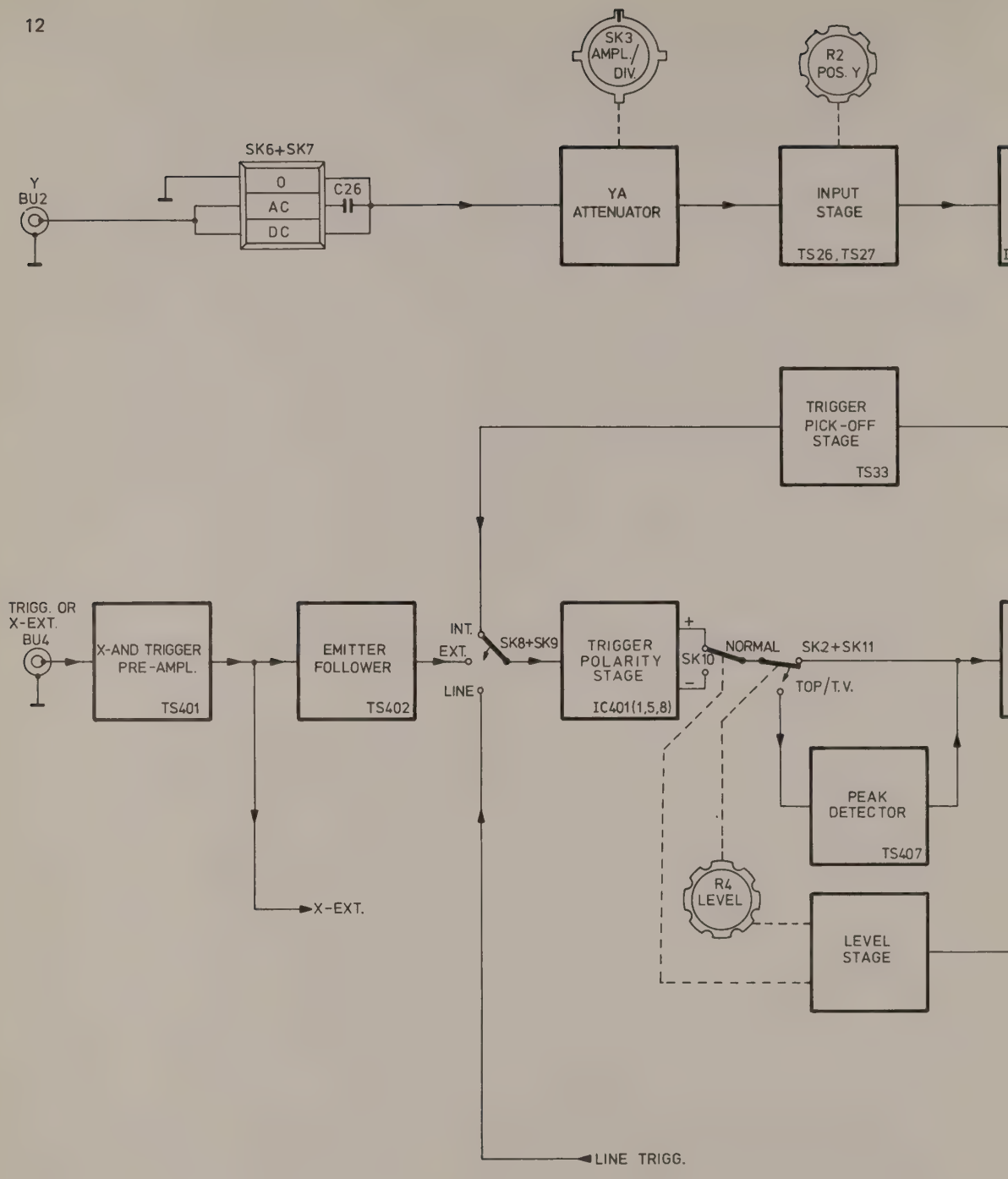
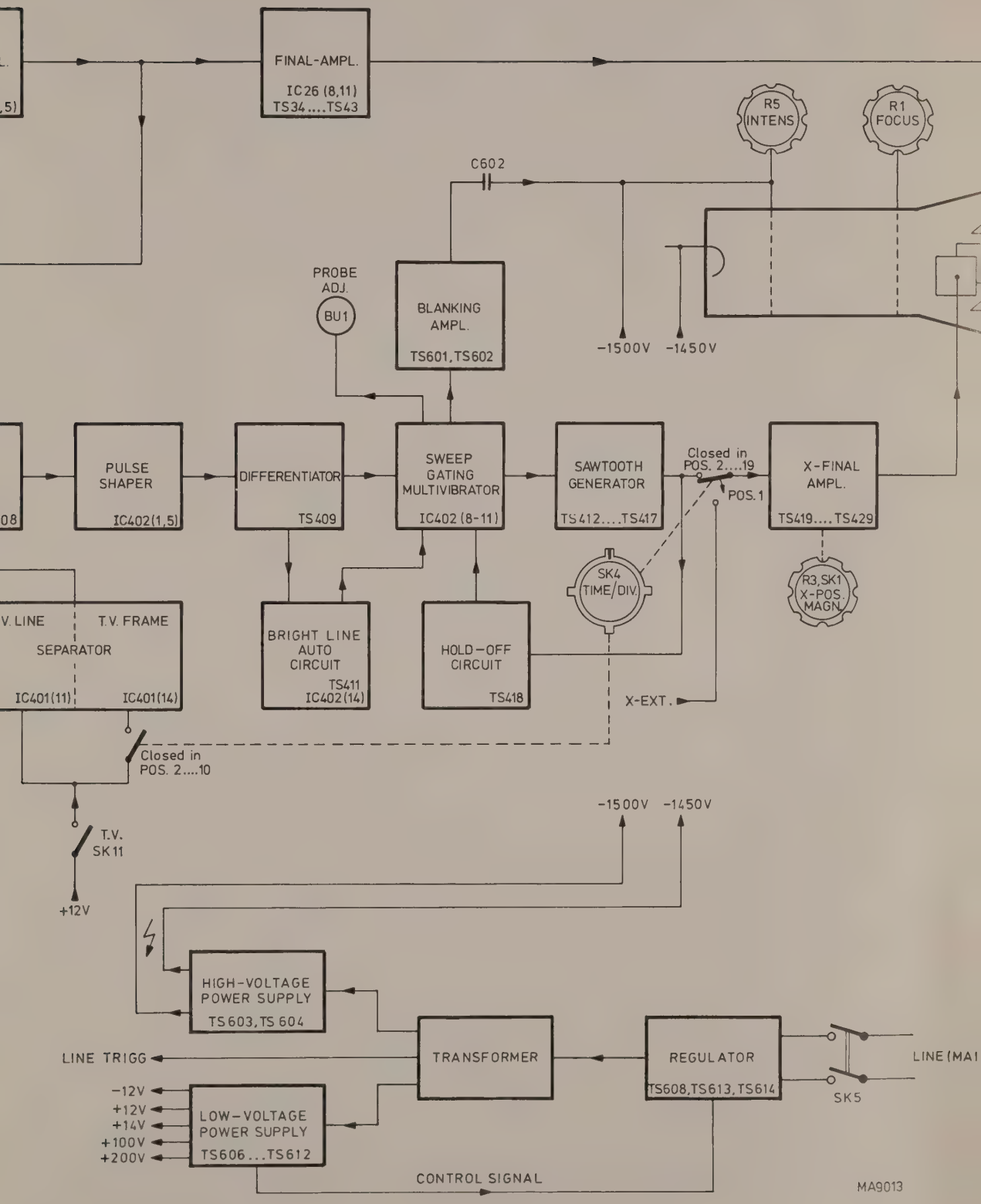


Fig. 1.2. Block diagram
Abb. 1.2. Blockschaltbild
Fig. 1.2. Schéma synoptique


FINAL-AMPL.
IC26 (8,11)
TS34....TS43
R5
INTENS
R1
FOCUS
C602
PROBE
ADJ.
BU1
BLANKING
AMPL.
TS601, TS602
-1500V
-1450V
PULSE
SHAPER
IC402(1,5)
DIFFERENTIATOR
TS409
SWEEP
GATING
MULTIVIBRATOR
IC402 (8-11)
SAWTOOTH
GENERATOR
TS412....TS417
Closed in
POS. 2....19
POS. 1
X-FINAL
AMPL.
TS419....TS429
SK4
TIME/DIV.
R3, SK1
X-POS.
MAGN.
T.V. LINE
T.V. FRAME
SEPARATOR
IC401(11)
IC401(14)
BRIGHT LINE
AUTO
CIRCUIT
TS411
IC402(14)
HOLD-OFF
CIRCUIT
TS418
X-EXT.
Closed in
POS. 2....10
T.V.
SK11
+12V
-1500V
-1450V
HIGH-VOLTAGE
POWER SUPPLY
TS603, TS604
LINE TRIGG
TRANSFORMER
REGULATOR
TS608, TS613, TS614
LINE (MA1
SK5
-12V
+12V
+14V
+100V
+200V
LOW-VOLTAGE
POWER SUPPLY
TS606...TS612
CONTROL SIGNAL
MA9013

	Designation		*Specification*
1.2.7	**Operating position**	:	Optional
1.2.8	**Supply voltages**	:	110 V; 127 V; 220 V and 240 V; a.c. ± 10% (46 Hz to 400 Hz)
	Power consumption	:	18 VA
1.2.9	**Mechanical data**		
	Height	:	140 mm incl. feet and handle
	Width	:	260 mm incl. handle
	Length	:	320 mm incl. front cover
	Weight	:	3.8 kg
1.2.10	**Cooling**		
	Natural convection		

1.3 ACCESSORIES

Accessories supplied with the instrument		Front cover BNC to banana adaptor Operating and service manual Contrast filter
Optional accessories	PM 9326	Passive probe 1 : 1/10 : 1 (1,1 m)
	PM 9327	Passive probe 1 : 1/10 : 1 (2,1 m)
	PM 9335	Passive probe 1 : 1 (1,5 m)
	PM 9335L	Passive probe 1 : 1 (2,5 m)
	PM 9336	Passive probe 10 : 1 (1,5 m)
	PM 9336L	Passive probe 10 : 1 (2,5 m)
	PM 9358/01	Passive probe 100 : 1 (1,5 m)
	PM 9353'	Active FET-probe; 1 : 1; 1:10; 1 : 100
	PM 9355	Current probe; 12 Hz ... 70 MHz
	PM 9346	Power supply for active probes
	PM 9380	Multi-purpose oscilloscope camera
	PM 8971	Adapter (oscilloscope to camera)
	PM 9051	BNC-4 mm adapter
		19-in rack-mounting (dimensioned sketch Fig. 3.27)
		Antistatic spray
		Trimming tool kit

See also chapter 3.5 "Information concerning accessories".

1.4 DESCRIPTION OF THE BLOCK DIAGRAM

1.4.1 Y channel

The vertical channel for the signal to be displayed comprises an input coupling switch, an input step attenuator, a source-follower input stage with protection circuit, a preamplifier, a trigger pick-off stage and a final amplifier.

The input stage protection circuit consists of a diode, which prevents damage to the field-effect transistors that could occur with excessive negative input potentials, and a resistor network protects the input stage against large positive voltage swings.

As the transistors of the balanced preamplifier stage share the same integrated circuit blocks, the resulting stabilisation provides a measure of correction to reduce the drift inherent in high-gain amplifiers.

The trigger pick-off stage supplies a trigger signal from one side of the balanced preamplifier to the trigger amplifier when internal triggering is selected.

Signal of the balanced final amplifier, is direct-coupled to the Y plates of the c.r.t.

1.4.2 Triggering

A triggering signal can be obtained from the vertical amplifier channel, via the trigger pick-off stage, from an external source, or internally from the mains supply (LINE triggering). The triggering signal is selected and normally fed, via the amplifier stage, to the pulse shaper which supplies well-defined trigger pulses to the sweep-gating multivibrator for starting the sawtooth generator.

Triggering from TV line and frame signals is facilitated by the sync separator and peak detector stages. The latter stage is switched into circuit also in the TOP position.

1.4.3 Time-base

The time-base generator circuit operates on the constant-current integrator principle.

The sweep-gating multivibrator, triggered by pulses from the differentiator and auto-circuit, starts the sawtooth generator. As a result, sawtooth waveforms, of duration dependent on the TIME/DIV switch position, are fed to the final X amplifier.

A gate pulse is supplied by the sweep-gating multivibrator for unblanking the c.r.t. during the forward sweep. In addition, this pulse is supplied to an external socket for probe adjustment, via a diode network.

1.4.4 X channel

Under the control of diode switching from the TIME/DIV switch, the X final amplifier receives its input signal from either the time-base sawtooth generator or from an external source (X EXT input socket via the X and trigger preamplifier). The X MAGN (x5) circuit is incorporated in the X final amplifier. The output of this amplifier is direct-coupled to the horizontal deflection plates of the c.r.t.

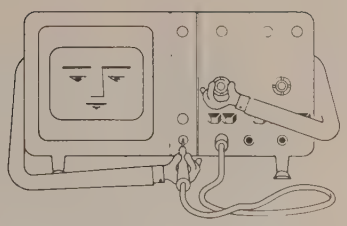
1.4.5 Cathode-ray tube circuit and power supplies

The high voltages for the c.r.t., which has an acceleration potential of 1.5 kV, are generated by a voltage multiplier circuit controlled by the stabilised power supply. The c.r.t. beam current is controlled by the INTENS potentiometer network across the e.h.t. supply and, during flyback, by the blanking pulses from the sawtooth generator via the beam blanking stage.

Regulation of the mains input voltage is achieved by a diode clipper network controlled by a signal fed back from a light-emitting diode in the +14 V rectified supply.

Fig. 2.1 Rear view

2. Directions for use



2.1 IMPORTANT SAFETY REGULATIONS

This instrument leaves the factory in safe and impeccable condition. In view of this and safe functioning, we recommend to follow carefully the instructions below.

2.1.1 Mains voltage

The instrument should be connected to an a.c. mains supply. On delivery the instrument is set to 220 V. If the instrument is to be used with 110 V, 127 V or 240 V supply, the appropriate voltage should be selected by turning the coin-slot adapter on the rear panel to indicate the voltage required (see Fig. 2.1.).

Before connecting

- Before connecting the instrument to the mains, visually check the cabinet, controls and connectors etc., to ascertain whether any damage has occurred during transport or storage.
- Check that the voltage adjusted corresponds to the nominal mains voltage.

Protection class

The present instrument meets the protection class I (protective earth) according to IEC 348 or VDE 0411. The mains cable supplied on delivery contains a protective conductor. Except for use in especially permitted rooms, the mains plug must be inserted into a mains socket with rim earthing only.

2.1.2 Repair and maintenance

Faults and special requirements

In the case, harmless functioning is no longer guaranteed, the instrument must be put out of operation and protected against unintentional use.

This is the case:

- when the instrument shows visible damages
- when the instrument does no longer work
- when the requirements (e.g. storage, transport) exceed the permissible limits.

Opening the instrument

The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts and also accessible terminals may be live.

The instrument shall be disconnected from all voltage sources before any adjustment, replacement or maintenance and repair during which the instrument will be opened.

If afterwards any adjustment, maintenance or repair of the opened instrument under voltage is inevitable, it shall be carried out only by a skilled person who is aware of the danger involved.

Bear in mind that capacitors inside the instrument may still be charged, even if the instrument has been separated from all voltage sources.

Repairing and replacing parts

Repairs must be performed competently. They must not affect the safety of the instrument. Take especially care that creepage and air distances between parts are not decreased.

For replacing, original parts must be used only. Different parts are permitted if they do not affect the safety of the instrument.

2.1.3 Fuses

The instrument is protected from overloads by a thermal fuse fitted between the mains transformer windings or on the heatsink of transistor TS 613. It can be replaced after having removed the instrument covers (see Section 2.3.10).

Only the fuses prescribed must be used.

2.1.4 Position

The instrument may be used horizontally or in several sloping positions by employing the carrying handle as a tilting bracket. To release the handle, push both pivot centre buttons A (see Fig. 2.2).

Ensure that the ventilation holes in the rear and bottom plates are free from obstructions.

Do not position the instrument on any surface which produces or radiates heat.

2.1.5 Installation, Mains adaption and connection, earthing

Mains adaption and connection
The instrument should be connected to an a.c. mains supply.
On delivery the instrument is set to 220 V. Before connecting to the mains, check that the mains-voltage transformer is set to the local mains voltage.
The voltage set is visible through an opening at the rear of the instrument.

If the instrument must be adjusted to another mains voltage, proceed as follows:
– disconnect the mains plug
– set the required voltage by rotating the voltage converter at the rear (see Fig. 2.1).

Earthing
The instrument should be connected to a protective earth in accordance with the local safety regulations. When the instrument is connected to a mains socket with rim-earth contacts, the cabinet is connected to earth via the three-core mains cable.

WARNING: **Any interruption of the protective conductor inside or outside the instrument, or disconnection of the protective earth terminal, is likely to make the instrument dangerous. Intentional interruption is prohibited.**
When an instrument is brought from a cold into a warm environment, condensation may cause a hazardous condition. Therefore, make sure that the earthing requirements are strictly adhered to.

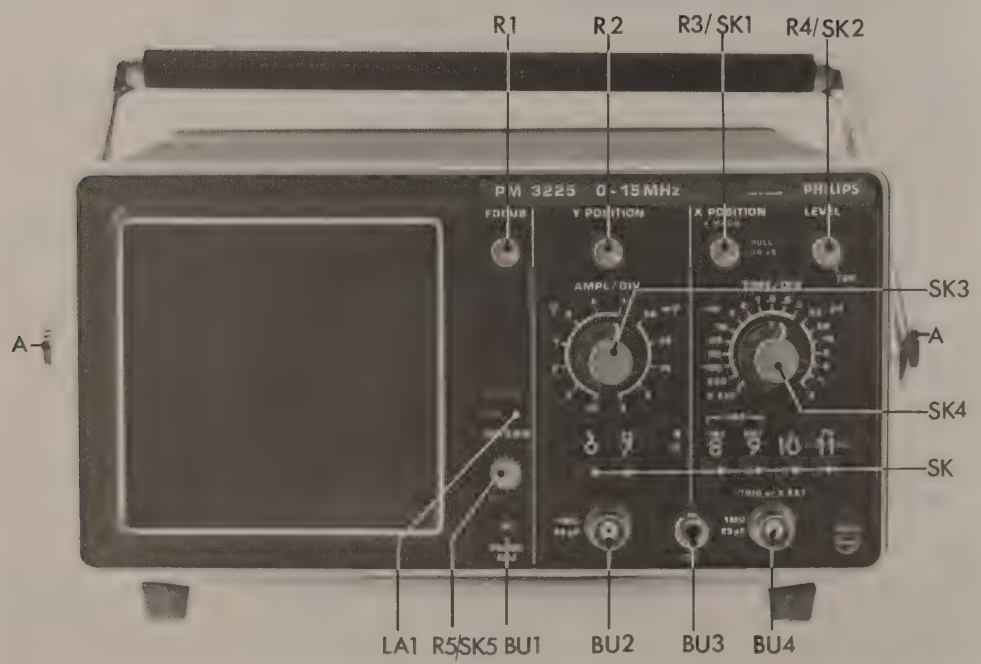


Fig. 2.2. Front view showing controls and sockets

2.1.6 Controls and sockets (Fig. 2.2)

FOCUS (R1)	Continuously variable control of the electron-beam focusing.
Y POSITION (R2)	Continuously variable control giving vertical positioning of the display.
X POSITION (R3) X MAGN (SK1)	Continuously variable control giving horizontal positioning of the display. Incorporates a switch for calibrated x5 magnification of the time-base.
LEVEL (R4) TOP (SK2)	Continuously variable control for selecting the level at which the time-base generator starts. The switch provides a TOP position for large pulse-shaped signals.
AMPL/DIV (SK3)	Control of the vertical deflection coefficients in 12 calibrated steps.
TIME/DIV (SK4)	Time-coefficient control of the time-base in 18 calibrated steps, plus a position for external X deflection (X EXT).
POWER ON (LA1)	Illuminates (red) to indicate instrument is switched on.
INTENS (R5) with OFF switch (SK5)	Continuously variable control of the trace brilliance, incorporating ON/OFF switch for supply to the oscilloscope.
O pushbutton (SK6)	Interrupts Y input connection and earths input circuit.
AC-DC pushbutton (SK7)	AC (depressed) : Y input via a coupling capacitor DC (released) : Y input direct coupled
TRIGGERING pushbuttons (SK8-SK11)	Controls for trigger source, slope and mode.
INT (SK8)	Internal triggering signal derived from Y channel.
EXT (SK9)	Triggering signal derived from a voltage applied to the TRIG or X EXT socket BU4.
LINE (SK8 + SK9 selected simultaneously)	Triggering signal derived from an internal voltage at mains frequency.
± (SK10)	Provides triggering on the positive slope of the signal when released, and triggering on the negative slope when depressed.
TV NORMAL } (SK11)	When depressed enables triggering on line or frame pulses of TV signals, according to the position of TIME/DIV switch SK4. Triggering on frame pulses in positions .5 ms/div to 200 ms/div. Triggering on line pulses in positions .2 ms/div to .5 µs/div.
PROBE ADJ (BU1)	Output terminal for calibrating test probes.
1 MΩ // 25 pF (BU2)	Input BNC socket for the vertical deflection signal.
⏚ (BU3)	Earth socket
TRIG or X EXT 1 MΩ // 25 pF (BU4)	Input BNC socket for external triggering signals or external X deflection.

2.2 OPERATION

2.2.1 Switching on the instrument

The mains cable is wound round the four feet on the base of the instrument.
After the oscilloscope has been connected to the mains in accordance with section 2.1.5, it may be switched on by means of the mains switch incorporated in the INTENS control; the red POWER ON lamp will light.

The oscilloscope will meet specifications (see Section 1.2) normally after a warming-up period of approximately 15 minutes. However, if the instrument has been subjected to an extremely cold environment (e.g. left in a car overnight in freezing conditions) and is then bought in for use in a warm room, a warming-up period of at least 2 hours should be allowed.

2.2.2 Preliminary settings of the controls

- Check that the correct mains voltage has been selected in accordance with section 2.1.5.
- Switch on the oscilloscope.
- Set INTENS control R5 to its mid-position.
- Select trigger source, mode and slope. If no trigger button is selected, the oscilloscope triggers in an automatic and internal mode.
- Display the trace by means of Y POSITION control R2.

The instrument is then ready for use.

2.2.3 Adjustment of attenuator probes

Probe sets PM 9326 and PM 9327

- Display a time-base line by selecting LINE mode (depress pushbuttons SK8 + SK9 simultaneously).
- Turn LEVEL control fully clockwise (position Top).
- Set AMPL/DIV switch SK3 to 5 mV/div.
- Connect the measuring lead to socket BU2 and place the tip of the probe on BU1 (see Fig. 2.2.).
- Select either .5 ms/div or .2 ms/div.
- Loosen the 'locking screw' and turn the 'probe body' (see Fig. 2.3.), in relation to the cable until correct adjustment is obtained.
- Secure the locking screw, ensuring that the adjustment is not altered.

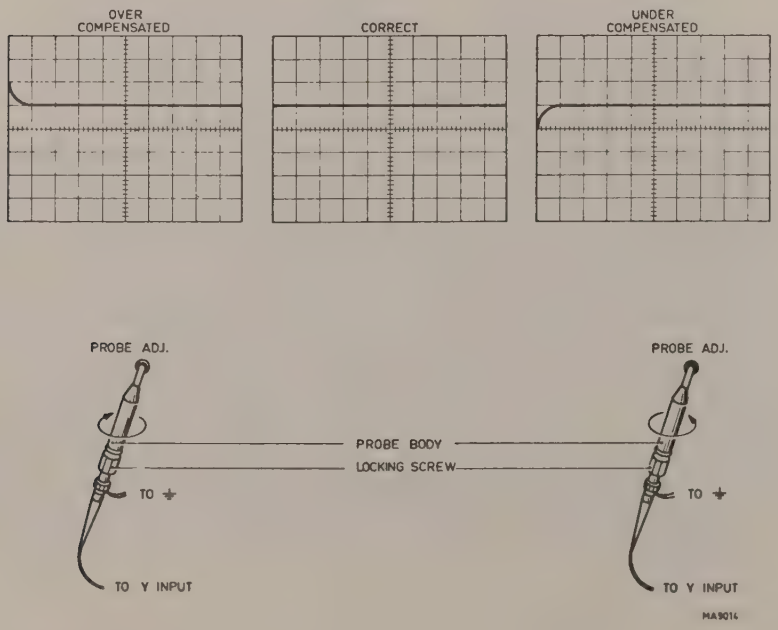


Fig. 2.3. Adjusting an attenuator probe

Probe sets PM 9336, PM 9336L and PM 9358

- Display a time-base line by selecting LINE mode (depress pushbuttons SK8 + SK9 simultaneously).
- Turn LEVEL control fully clockwise (position TOP).
- Depress pushbutton SK7, i.e. select AC.
- Set AMPL/DIV switch SK3 to 5 mV/div.
- Connect the compensation box to BU2 and place the tip of the probe on BU1 (see Fig. 2.2.).
- Select either .5 ms/div or .2 ms/div.
- Insert a small screwdriver through the hole in the compensation box and adjust the trimmer to obtain a correct display as shown in Fig. 2.4.

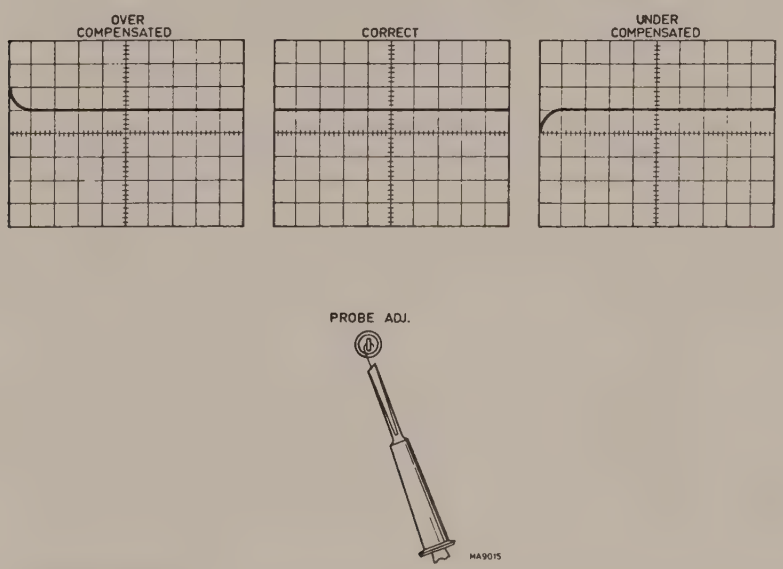


Fig. 2.4. Probe compensation

2.2.4 Input functions

The PM 3225 is provided with a vertical channel that can be used for either YT measurements in combination with the time-base generator, or XY measurements up to frequencies of 100 kHz.

YT Measurements
An input signal on BU2 is displayed against the internal time-base generator over the range of the TIME/DIV switch SK4 for normal operation (i.e. not in the X EXT position of SK4).

XY Measurements
If the TIME/DIV switch SK4 is switched to the X EXT position the time-base generator is switched off.
An external input on the TRIG or X EXT frontpanel socket BU4 is now connected to the X amplifier channel.
The X MAGN front-panel switch SK1 PULL FOR x5 facility is still available. In this mode, XY measurements can be made up to a frequency of 100 kHz.

Influence of the 0 and AC-DC switches
Signals to be studied can be fed to input socket BU2. Depending on the composition of the signal, the AC-DC switch should be depressed or released.
In the DC position, the input is coupled direct to the Y amplifier. Because the Y amplifier is d.c. coupled, the entire bandwidth of the instrument is available. Therefore, the complete input voltages are fed to the deflection plates, which means that the d.c. components result in trace shifts on the screen.
This may cause difficulties when a.c. signals superimposed on high direct voltages have to be displayed.
In order to make the a.c. signal visible in this case, greater attenuation will be necessary with the result that the a.c. signal will also be strongly attenuated.
However, by selecting the AC position of SK7, a blocking capacitor is connected between the input socket and the Y amplifier. As a result of this, d.c. voltages are blocked, but the lower frequencies are also suppressed or attenuated. When squarewave signals of low frequency are displayed, this will result in some pulse droop.
With the 0 pushbutton selected, it is immediately possible to determine the zero volt d.c. level. The connection between the amplifier input and the input socket is interrupted, the amplifier input being earthed.

2.2.5 Triggering

General
In order to obtain a stationary trace, the horizontal deflection must always be started at a fixed point of the signal. The sweep-gating multivibrator is, therefore, started by narrow trigger pulses formed in the trigger unit, controlled by a signal originating from the vertical input signal, an external source, or internal mains pulses (LINE mode).

Trigger level
In the case of a complicated signal in which a number of non-identical voltage shapes occur periodically, the time axis should always be started with the same voltage shape so as to obtain a stationary trace. This is possible when one of the details has a deviating amplitude. By means of the LEVEL control, the trigger level can be set in such a way that only this larger voltage variation passes this level. In the TOP mode it is possible to display a large variety of waveforms of different amplitude and shape.

Bright line auto circuit
The oscilloscope operates in the free-run triggering mode when no signal is present. A time-base line is therefore visible on the screen if no trigger signal is present; this provides a useful zero reference indication.

External triggering
Where signals vary widely in amplitude, external triggering can be applied from a signal of constant amplitude and equivalent frequency. External triggering is even more important where complex signals and pulse patterns could give rise to double traces. This obviates the necessity of readjusting the level setting at every variation of the input signal. The external input signal is applied to TRIG or X EXT socket BU4.

Triggering with the mains frequency (LINE mode)
In this instance, the triggering signal is a sinewave of mains frequency. This trigger source is useful if the frequency of the signal under observation is derived from the mains supply. It is, for example, possible to recognize the hum component of a signal by triggering on that component.
The mains triggering facility (LINE) is selected by depressing pushbuttons (SK8 + SK9) INT + EXT simultaneously.

Triggering with television signals
It is possible to trigger on the line or frame sync pulses of television signals. In positions .5 ms/div to 200 ms/div of the TIME/DIV switch SK4, triggering takes place on the frame sync pulses, and in positions .2 ms/div to .5 μs/div of SK4, on the line sync pulses.
The position of the trigger slope switch SK10 must correspond to the inverse polarity of the video information of the signal; i.e. — position of SK10 for a positive signal, + position of SK10 for a negative video signal.

2.2.6 Time-base magnifier

The magnifier is operated by pulling the switch incorporated in the X position control.
When this switch is in the x5 position, the time-base sweep speed is increased 5 times. The sweep time is therefore determined by dividing the indicated TIME/DIV value by 5.

2.3 DISMANTLING THE INSTRUMENT

2.3.1 General information

This section provides the dismantling procedures required for the removal of components during repair and routine maintenance operations. All circuit boards removed from the oscilloscope should be adequately protected against damage, and all normal precautions regarding the use of tools must be observed (see also chapter 2.) During dismantling procedures, a careful note of all leads disconnected must be made so that they may be reconnected to their correct terminals during assembly.

Always ensure that the mains supply is disconnected before removing any instrument cover plates.

Damage may result if the instrument is switched on when a circuit board has been removed, or if a circuit board is removed within one minute of switching off the instrument.

2.3.2 Removing the instrument covers

The instrument is protected by three covers: a front-panel protection cover, a wrap-around cover with carrying handle, and a rear cover plate.

To facilitate removal of the wrap-around cover and the rear cover, first ensure that the front cover is in position.

Then proceed as follows:
- hinge the carrying handle clear of the front cover to this end, push both pivot centre buttons A (see Fig. 2.2.).
- stand the instrument on its protective front cover on a flat surface
- slacken the coin-slot screw located in the centre of the rear cover plate (see Fig. 2.1.)
- remove the rear cover plate
- slide out the nylon grommet from the wrap-around cover to free the mains lead
- lift off the wrap-around cover
- for access to the front-panel, stand the instrument horizontally and snap off the front cover.
- for access to the high tension part, slide forward transparent protective cover out of the rear panel holes.

2.3.3 Removing the bezel and graticule

- to extract bezel, swivel out by applying slight pressure to the left-hand edge (see Fig. 2.5.)
  The mask and graticule can both be unclipped from the bezel by slight pressure from the front.

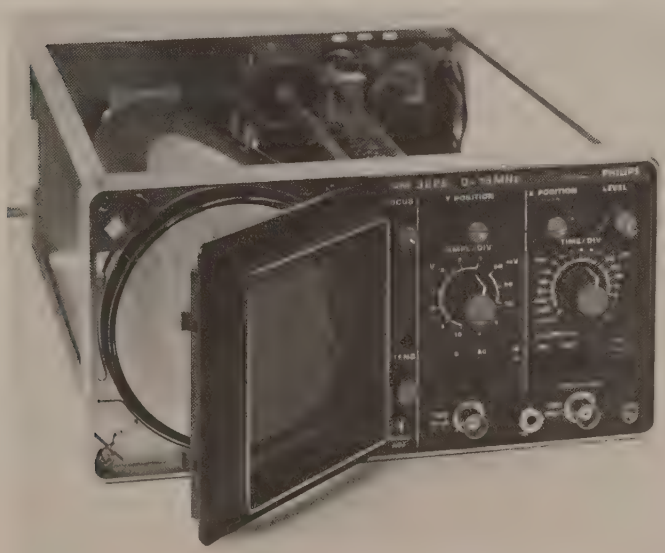


Fig. 2.5. Removing bezel and graticule

2.3.4 Removing the text plate

- prize off covers from the AMPL/DIV, TIME/DIV and X POSITION controls.
- unscrew hexagon nuts and the slotted nut and remove the knobs.
- pull off all remaining knobs.
- unscrew remaining hexagon nuts securing the textplate.
- carefully remove the text plate.

2.3.5 Removing the FOCUS and INTENS/OFF controls

- remove instrument covers as described (see Section 2.3.2.)
- remove appropriate front-panel control knob.
- spring out nylon brackets B (Fig. 2.6.) through the holes of the rear panel.
- simultaneously rotate spindle C (Fig. 2.6.) and pull to withdraw square through alignment hole.
- remove plastic bracket and spindle.
- unscrew hexagonal nut D (Fig. 2.6.) to remove potentiometer.

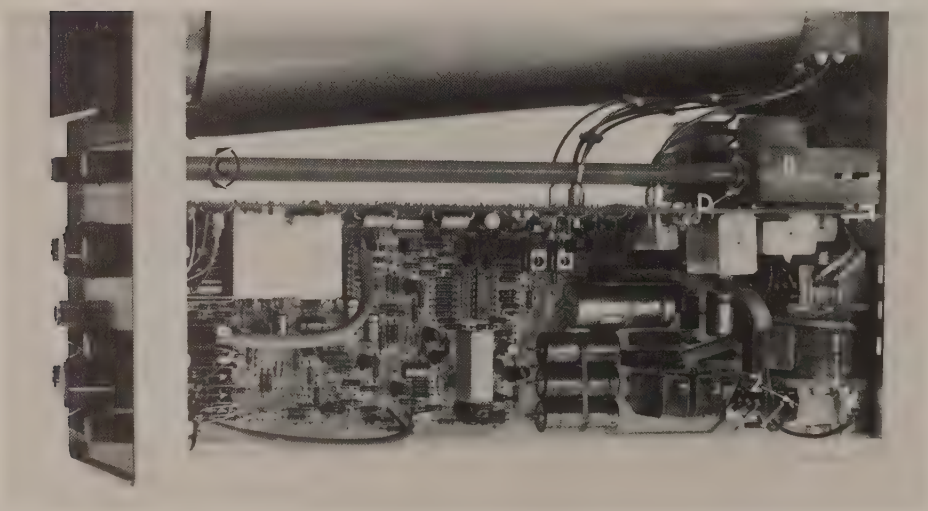


Fig. 2.6. Dismantling

2.3.6 Removing the electronic unit assembly complete

- remove instrument covers as described (see Section 2.3.2.).
- slide forward transparent protective cover out of rear panel holes.
- remove two Stocko connectors and the flying lead connectors.
  Note that probe adjustment lead to front panel must also be removed.
- remove four screws and one nut located as follows:
  . 3 screws E (Fig. 2.7.) holding p.c. boards to rear plate.
  . 1 screw F(Fig. 2.7.) behind front panel (top).
  . 1 nut G (Fig. 2.7.) behind front panel (bottom).
- withdraw complete electronic unit assembly through front panel together with text plate and knobs.

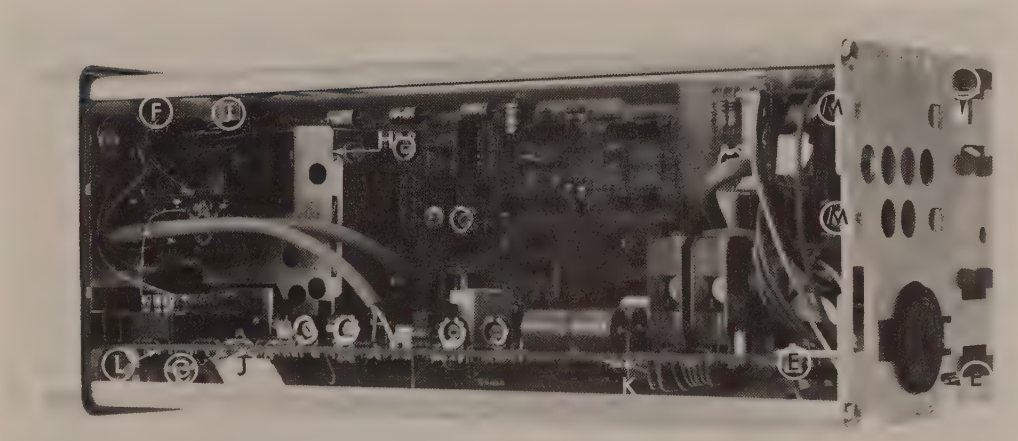


Fig. 2.7. Dismantling

2.3.7 Access to attentuator unit for replacement

- remove electronic unit assembly in accordance with 2.3.6.
- unhook attenuator screening cover plate by pressing in lip (H) on top edge (see Fig. 2.7.).
- unsolder wires to attenuator printed-circuit board from the printed side using a vacuum soldering iron.
- unscrew two screws J (Fig. 2.7.).
- unhook angle bracket K located halfway along edge of the printed-circuit board (Fig. 2.7.).
- remove text plate and hexagonal nuts securing attenuator (see Section 2.3.4).

For replacement, remove existing switch and make identical connections on new switch.

2.3.8 Removing a printed-circuit board

- remove the instrument covers as described (see Section 2.3.2).
- remove attentuator screening cover plate as described (see Section 2.3.7).
- unsolder appropriate connections.
- unhook angle bracket K located halway along edge of the p.c. board (Fig. 2.7).
- to remove horizontal board: remove one screw L securing it to the front panel (Fig. 2.7).
- to remove vertical board: remove appropriate attenuator connections and two screws J securing it to the front panel (Fig. 2.7.).

2.3.9 Removing the mains transformer

- remove the instrument covers as described (see Section 2.3.2).
- unsolder connecting wires, noting positions.
- remove the 6-way Stocko connector.
- unscrew two mounting screws M (Fig. 2.7.).
- lift out transformer sideways.

2.3.10 Fuse replacement

- remove the instrument covers as described (see Section 2.3.2).
- unsolder the fuse terminals 1 and 2 (see Section 2.1.3 and Fig. 2.8.).
- remove the fuse; to this end, bend the housing slightly to the outside so that the locking pin can be disengaged.
- a new fuse is removed from its housing in the same way as described above. It is then pushed in the same housing as the old one until the locking pin snaps into the hole, the loop pointing to the "1" terminal.
- after having terminals "1" and "2" soldered, the instrument can be considered as ready for use.

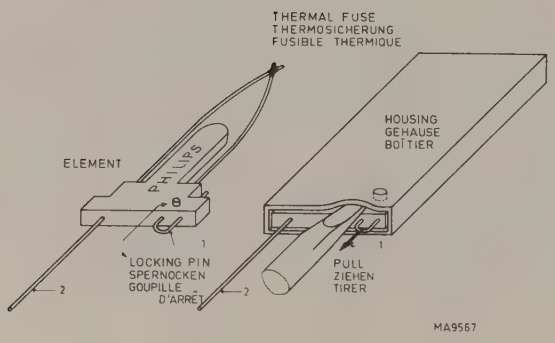


Fig. 2.8. Fuse replacement

2.3.11 Removing the cathode-ray tube

- remove instrument covers as described (see Section 2.3.2.).
- remove screws N and P behind front panel (see Fig. 2.9.).
- remove bezel (see Section 2.3.3.).
- remove plastic locking piece.
- spring the two nylon bracket lips Q (see Fig. 2.6.), at rear of tube, inwards and taking care of mumetal screen, withdraw the c.r.t. through front panel sufficiently to allow the c.r.t. base connector to be removed, (push in nylon bracket to assist).
- slacken clamping screw R in bracket around tube face (Fig. 2.9.).

Note: When fitting a c.r.t., well-adjust the tube face against graticule. Take care not to overtighten the clamping screw R (screw pressure $\leqslant$ 40 newton x cm).

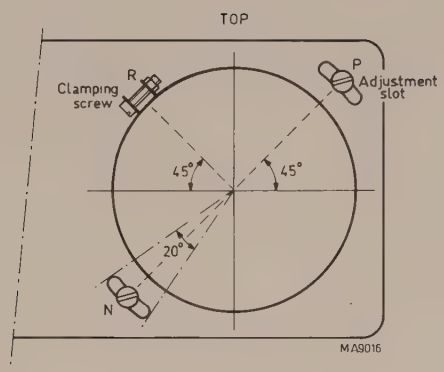


Fig. 2.9. Cathode-ray tube positioning

2.3.12 Removing the carrying handle

- prise off the plastic centre buttons from each pivot with a screwdriver.
- remove the posidrive screws.

2.3.13 Replacing a push-button switch

- Remove the printed-circuit board in accordance with section 2.3.8 for replacing a switch in this unit.
- Straighten the 4 retaining plugs of the relevant switches as shown in Fig. 2.10.
- Break the body of the relevant switch by means of a pair of pliers and remove the pieces. The soldering pins are then accessible.
- Remove the soldering pins and clean the holes in the printed-wiring board (e.g. with a suction soldering iron).
- Solder the new switch onto the printed-circuit board.
- Bend the 4 retaining lugs back to their original positions.

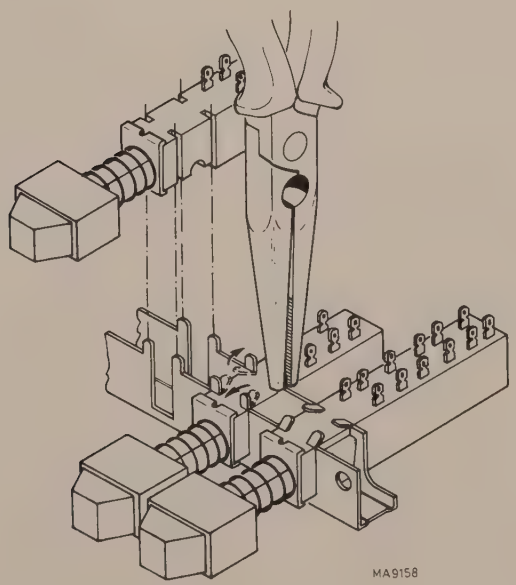
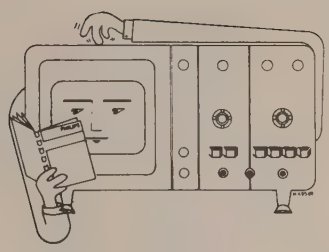


Fig. 2.10. Replacing a push-button switch

Gebrauchsanleitung

1. Allgemeines



1.1 EINLEITUNG

Der tragbare 15-MHz-Oszilloskop PM 3225 ist ein kompaktes leichtes Gerät. Es lässt sich besonders leicht bedienen und kann durch seine vielseitigen Anwendungsmöglichkeiten für Wartungsarbeiten sowie für Labor und Unterrichtszwecke verwendet werden.

Das Gerät besitzt vollautomatische Triggerung, Netztriggerung und Triggerung mit Zeilen-und-Bildsynchronimpulsen eines Fernsehsignals.

Der ausnutzbare Bildschirm der Elektronenstrahlröhre ist mit einem externen Raster in 8 x 10 Div. kalibriert. Das Gerät ist mit Ausnahme der Elektronenstrahlröhre volltransistorisiert, alle Bauelemente befinden sich auf Printplatten, um Wartungsarbeiten und Zugang zu erleichtern.

Der durchdachte Entwurf und die zweckmässige Ausführung gewährleisten mühelose Bedienung and zuverlässigen Betrieb.

Abb. 1.1. Frontansicht PM 3225

1.2 TECHNISCHE DATEN

Allgemeine Hinweise

Nur Zahlenwerte mit Toleranzangaben werden garantiert.
Zahlenwerte ohne Toleranzangaben sind Durchschnittswerte und dienen zur Information.

Benennung	*Beschreibung*
1.2.1 Elektronenstrahlröhre	
Type	: D10 – 160 GH
Schirmtypen	: P31 (GH) P7 (GM) wahlweise
Ausnutzbare Schirmfläche	: 8 x 10 Div.; 1 Div = 7.5 mm
Beschleunigungsspannung	: 1,5 kV
Messraster	: Extern, nicht beleuchtet
1.2.2 Y-Verstärker	
Frequenzbereich	: Gleichspannungskopplung 0 Hz ... 15 MHz (–3 dB) : Wechselspannungskopplung 2 Hz ... 15 MHz (–3 dB)
Anstiegzeit	: 25 ns
Überschwingen	: ⩽ 3 %((Testimpuls: 6 div. Amplitude, 3 ns Anstiegszeit)
Ablenkkoeffizient	: 2 mV/div. ... 10 V/div., in zwölf kalibrierten Stellungen, Folge 1-2-5; Fehlergrenzen ± 3 %
Maximal zulässige Eingangsspannung	: ± 400 V (Gleichspannung + Spitzenwert der Wechselspannung), unempfindlich gegen einzelne kurzzeitige Spannungsimpulse bis 1000 V
Vertikaler Verschiebungsbereich	: 16 div.
Dynamischer Bereich	: 24 div. für Sinusspannungen bis 1 MHz 6 div. für Sinusspannungen bis 15 MHz
Eingangsimpedanz	: 1 MΩ // 25 pF
1.2.3 X-Verstärker	
Frequenzbereich	: von Gleichspannung bis 100 kHz
Ablenkkoeffizient	: 5 V/div.; Fehlergrenze ±15% 1 V/div. in Stellung x5 (X-MAGN)
Maximal zulässige Eingangsspannung	: ± 400 V (Gleichspannung + Spitzenwert der Wechselspannung), unempfindlich gegen einzelne kurzzeitige Spannungsimpulse bis 1000 V
Eingangsimpedanz	: 1 MΩ // 25 pF
Phasenverschiebung	: 5° bei 50 kHz
1.2.4 Zeitablenkung	
Ablenkkoeffizient	: 0.2 s/div ... 0.5 µs/div. in 18 kalibrierten Stufen, 1-2-5 Folge
Fehlergrenze der Ablenkkoeffizienten	: ± 5%
Dehnung	: x5, 1 kalibrierte Stufe
Zusätzlicher Fehler	: 2%

1.2.5 Triggerung

Triggerquellen	:	Intern Extern Netzfrequenz
Triggerempfindlichkeit	:	Intern: level — ⩽0,75 div. bei 100 kHz 1,5 div. bei 15 MHz top — ⩽2 div. bei 15 MHz TV — 0,5 div. bei Zeilen oder Bildsynchronimpulsen Extern: level — 0,75 V bei 100 kHz 1,5 V bei 15 MHz top — ⩽2 V bei 15 MHz TV — 0,5 V bei Zeilen oder Bildsynchronimpulsen
Eingangsimpedanz	:	1 MΩ // 25 pF
Maximal zulässige Eingangsspannung	:	± 400 V (Gleichspannung + Spitzenwert der Wechselspannung), unempfindlich gegen einzelne kurzzeitige Spannungsimpulse bis zu 1000 V
Betriebsarten	:	Automatischer Freilauf des Zeitablenkgenerators, wenn kein Triggersignal vorhanden ist. a. Einstellbarer Triggerpegel über 12 div. oder 12 V. Kleinste Triggerfrequenz für Sinusspannung ist 10 Hz. b. Top (Spitze)
Triggerflanke	:	+ oder —
Triggerung mit Fernsehsignalen (gekoppelt mit TIME/div.)	:	Bildfrequenz in den Stellungen .5 ms/div. ... 200 ms/div. Zeilenfrequenz in den Stellungen .2 ms/div. ... 5 µs/div.
Messkopf-Einstellung	:	Bedingungen, siehe Abschnitt 2.2.3.

1.2.6 Einflussgrössen

Die unter 1.2.6 erwähnten Daten gelten nur dann, wenn das Gerät gemäss den offiziellen Prüfverfahren kontrolliert wurde. Einzelheiten, die diese Verfahren und die Fehlergrenzenkriterien betreffen, können von der PHILIPS Organisation Ihres Landes oder von N.V. PHILIPS GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPT., EINDHOVEN, NIEDERLANDE angefordert werden.

1.2.6.1 Temperatur

— Bezugswert	:	23°C
— Nennbetriebsbereich	:	+5 °C bis +40 °C
— Betriebsbereichsgrenzen	:	—10 °C und +55 °C
— Lagerung und Transport	:	—40 °C bis +70 °C

1.2.6.2. Höhe

Betriebsgrenzbereich	:	5000 m } in freier Luft
Transportgrenzbereich	:	15000 m }

1.2.6.3 Luftfeuchte

Entspricht den Anforderungen gemäss IEC 60 Db

1.2.6.4. Stossfestigkeit

1000 Stösse von 10 g, ½ Sinus, Dauer 6 ms, in jeder von 3 Richtungen.

1.2.6.5. Vibration

30 Minuten in jeder von 3 Richtungen, 10-150 Hz; 0,7 mm (Spitze-Spitze) und 5 g maximale Beschleunigung

1.2.6.6. Störgrad

Entspricht den Anforderungen gemäss VDE, Störgrad K.

1.2.7. Betriebslage : Beliebig

1.2.8. Speisespannungen : 110 V; 127 V; 220 V und 240 V; Wechselspannung ± 10 % (46 Hz ... 400 Hz)

Leistungsaufnahme : 18 VA

1.2.9. Gehäuse

Gesamtabmessung

Höhe : 140 mm

Breite : 260 mm

Länge : 320 mm

Gewicht : 3,8 Kg

1.2.10. Kühlung : Natürliche Luftzirkulation

1.3. ZUBEHÖR

Standardzubehör :

1 Frontdeckel
1 Adapter BNC-4 mm
1 Anleitung
1 Kontrastplatte

Sonderzubehör :

PM 9326	Passiver Abschwächer-Messkopfsatz (10:1), Kabellänge 1,1 m
PM 9327	Passiver Abschwächer-Messkopfsatz (10:1), Kabellänge 2,1 m
PM 9335	Passiver Messkopfsatz (1:1), Kabellänge 1,5 m
PM 9335L	Passiver Messkopfsatz (1:1), Kabellänge 2,5 m
PM 9336	Passiver Abschwächer-Messkopfsatz (10:1), Kabellänge 1,5 m
PM 9336L	Passiver Abschwächer-Messkopfsatz (10:1), Kabellänge 2,5 m
PM 9358/01	Passiver Abschwächer-Messkopfsatz (100:1), Kabellänge 1,5 m
PM 9353	Aktiver Abschwächer-Messkopfsatz (100:1); 10:1; 1:1)
PM 9355	Strommesskopf; 12 Hz ... 70 MHz
PM 9346	Speisegerät für aktive Messkopfsätze
PM 9380	Mehrzweck-Registrierkamera
PM 8971	Adapter (Oszilloskop/Kamera)
PM 9051	Adapter BNC-4 mm

19" Gestell (Masszeichnung Abb. 3.27)
Antistatik Flüssigkeit (Sprühdose)
Abgleichbesteck

Siehe auch Abschnitt 3.5. "Information concerning accessories".

1.4 BESCHREIBUNG DES BLOCKSCHALTBILDS (siehe Abb. 1.2., Seite 12)

1.4.1. Y-Kanal

Der Y-Kanal besitzt einen Eingangskopplungsschalter, einen Abschwächer, einen Impedanzwandler mit Schutzschaltung, einen Vorverstärker, eine Triggertrennstufe und einen Endverstärker.
Die Schutzschaltung besteht aus einer vorgespannten Diode, die eine Beschädigung des Feldeffekttransistors durch zu grosse negative Eingangsspannungen verhindert; ein Widerstandsnetzwerk schützt gegen zu hohe positive Eingangsspannungen.
Die Transistoren der Differenz-Vorverstärkerstufe sind jeweils in einem Gehäuse integriert. Dadurch ist der Arbeitspunkt der hochempfindlichen Verstärker-Stufen weitgehend temperaturkompensiert.
Die Triggertrennstufe liefert bei interner Triggerung ein Triggersignal vom Vorverstärker an den Triggerverstärker.
Das Ausgangssignal des Endverstärkers gelangt direkt an die Y-Ablenkplatten der Elektronenstrahlröhre.

1.4.2. Triggerung

Ein Triggersignal kann entweder über die Triggertrennstufe dem Y-Verstärker oder einer externen Quelle oder intern dem Netzteil entnommen werden. Das gewählte Triggersignal gelangt über eine Verstärkerstufe an den Impulsformer. Der Impulsformer liefert über den Differentiator und den Sweep-gating-Multivibrator eindeutige Triggerimpulse zum Starten des Sägezahngenerators.
Der Synchronseparator und der Spitzendetektor ermöglichen Triggerung mit Zeilen- und Bildimpulsen. Der Spitzendetektor ist auch in Stellung TOP in Betrieb.

1.4.3. Zeitbasiseinheit

Der Zeitbasisgenerator arbeitet nach dem Prinzip des Konstantstrom-Integrators. Der Sweep-gating-Multivibrator, – getriggert von Impulsen des Differenzierglieds und der Triggerautomatik – startet den Sägezahngenerator.
Es entstehen Sägezähne, deren Dauer kalibriert mit dem Schalter TIME/DIV einstellbar ist. Der X-Endverstärker wird mit diesen Sägezähnen angesteuert.
Der Sweep-gating-Multivibrator liefert einen Torimpuls für die Helltastung der Elektronenstrahlröhre während des Hinlaufs. Zusätzlich wird dieser Impuls über ein Dioden-Netzwerk der Buchse PROBE-ADJ für den Messkopfabgleich zugeleitet.

1.4.4 X-Kanal

Über einen Diodenschalter erhält der X-Endverstärker sein Eingangssignal je nach Stellung des Schalters TIME/DIV entweder vom Zeitbasisgenerator oder aus einer externen Spannungsquelle (Eingangsbuchse X EXT über den X- und Triggervorverstärker).
Die X-MAGN-Schaltung ist im X-Endverstärkers enthalten. Der Ausgang dieses Verstärkers ist direkt mit der horizontalen Ablenkplatten der Elektronenstrahlröhre verbunden.

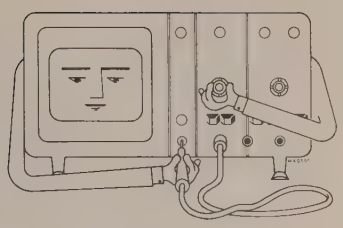
1.4.5 Elektronenstrahlröhre und Netzteil

Die Spannungen für die Elektronenstrahlröhre und die 1,5-kV-Beschleunigungsspannung werden von einem Spannungsvervielfacher im stabilisierten Netzteil erzeugt. Der Elektronenstrahl der Röhre wird beim Hinlauf von einem mit dem Potentiometer INTENS eingestellten Potential hellgesteuert und beim Rücklauf von Impulsen des Sägezahngenerators über die Strahlaustaststufe ausgetastet.

Das Netzteil wird eingangseitig mit einem gesteuerten Strombegrenzer geregelt. Der Strombegrenzer wird von einem Signal eines (Strom/Licht – Licht/Strom) Umsetzers gesteuert. Dieses Steuersignal wird vom gleichgerichteten +14 V Speiseteil nach der Netzteil-Eingangsseite rückgekoppelt.

Abb. 2.1 Rückansicht

2. Gebrauchsanleitung



2.1 WICHTIGE SICHERHEITSTECHNISCHE HINWEISE

Dieses Gerät hat das Werk in sicherheitstechnisch einwandfreiem Zustand verlassen. Zur Erhaltung dieses Zustands und seines gefahrlosen Betriebs empfehlen wird, die nachfolgenden Hinweise sorgfältig zu beachten.

2.1.1 Netzspannung

Das Gerät darf nur an Wechselspannung betrieben werden. Bei Auslieferung ist das Gerät auf eine Netzspannung von 220 V eingestellt. Soll das Gerät an 110 V, 127 V oder 240 V Netzspannungen betrieben werden, lässt sich die erforderliche Spannung durch Drehen des Spannungsumschalters an der Rückwand einstellen (siehe Abb. 2.1).

Vor dem Anschliessen

- Vor Anschluss des Geräts an das Netz, ist eine Sichtkontrolle des Gehäuses, der Bedienungsorgane, der Anschlüsse u.s.w. vorzunehmen, um sich zu überzeugen, dass das Gerät während Transport oder Lagerung nicht beschädigt wurde.
- Es ist sicherzustellen, dass die eingestellte Betriebsspannung des Geräts und die Nenn-Netzspannung übereinstimmen.

Schutzklasse

Dieses Gerät ist ein Gerät der Schutzklasse I (Schutzleiteranschluss) gemäss IEC348 oder VDE0411. Die mitgelieferte Netzzuleitung enthält einen Schutzleiter. Ausser in besonders zugelassenen Räumen darf der Netzstecker nur in Schutzkontaktsteckdosen eingeführt werden.
Jede Unterbrechung des Schutzleiters, innerhalb oder ausserhalb des Geräts, ist unzulässig.

2.1.2 Reparatur und Wartung

Fehler und aussergewöhliche Beanspruchungen

Wenn anzunehmen ist, dass ein gefahrloser Betrieb nicht (mehr) möglich ist. so ist das Gerät ausser Betrieb zu nehmen und gegen unabsichtlichen Betrieb zu sichern.
Dieser Fall tritt ein,

- wenn das Gerät sichtbare Beschädigungen aufweist,
- wenn das Gerät nicht mehr arbeitet,
- nach Überbeanspruchungen jeglicher Art (z.B. Lagerung, Transport), die die zulässigen Grenzen überschreiten.

Öffnen des Geräts

Beim Abnehmen von Abdeckungen oder Öffnen von Teilen mit Werkzeug können spannungsführende Teile freigelegt werden. Auch können Anschlussstellen spannungsführend sein.
Vor dem Öffnen des Geräts muss das Gerät von allen Spannungsquellen getrennt sein.
Wenn danach eine Kalibrierung, Wartung oder Reparatur am geöffneten Gerät unter Spannung unvermeidlich ist. so darf das nur durch eine Fachkraft geschehen, welche die damit verbundenen Gefahren kennt.
Kondensatoren im Gerät können noch geladen sein, selbst wenn das Gerät von allen Spannungsquellen getrennt wurde, die Schaltbilder sind zu beachten.

Reparatur, Ersatz von Teilen

Reparaturen sind fachgerecht durchzuführen. Dabei ist besonders darauf zu achten, dass die konstruktiven Merkmale des Geräts nicht sicherheitsmindernd verändert werden. Insbesondere dürfen die Kriech- und Luftstrecken und die Abstände durch die Isolierung hindurch nicht verkleinert werden.
Zum Ersatz nur Original-Teile verwenden. Andere Ersatzteile sind nur zulässig wenn dadurch die sicherheitstechnischen Eigenschaften des Geräts nicht verschlechtert werden.

2.1.3 Sicherungen

Das Gerät ist gegen Überlastung durch eine Thermosicherung geschützt, die sich zwischen den Wicklungen des Netztransformators oder am Kühlkörper von TS613 befindet. Die Sicherung lässt sich nach Abnahme der Gerätedeckel ersetzen (siehe Abschnitt 2.3.10).
Es dürfen nur die vorgeschriebenen Sicherungen verwendet werden.

2.1.4 Betriebslage

Das Gerät kann in horizontaler Lage, in vertikaler Lage, oder mit Hilfe des heruntergeklappten Tragbügels in verschiedenen gekippten Lagen aufgestellt und betrieben werden. Um den Tragbügel frei zu setzen, beide Schwenkknöpfe A(siehe Abb. 2.2) drücken.
Die Belüftungsöffnungen in Bodenplatte und Deckel dürfen nicht verdeckt werden.

Es ist darauf zu achten, dass das Gerät nicht auf andere Wärmequellen gestellt oder übermässiger Wärmeeinstrahlung ausgesetzt wird.

2.1.5 Inbetriebnahme (Netzanpassung und - anschluss, Erdung)

Anpassung und anschluss
Dieses Gerät darf nur an Wechselspannung betrieben werden.
Es ist bei Auslieferung auf einen Netzspannungsbereich von 220 V eingestellt.
Vor dem Anschliessen an das Netz ist zu prüfen, ob der Netzspannungstransformator auf die örtliche Netzspannung (± 10 %) eingestellt ist. Die eingestellte Spannung ist durch eine Öffnung an der Rückseite des Geräts sichtbar.
Soll das Gerät auf einen anderen Netzspannungsbereich umgestellt werden, ist wie folgt zu verfahren:
- Netzstecker herausziehen.
- Die erforderliche Spannung durch Drehen des Spannungsumschalters an der Rückwand einstellen (siehe Abb. 2.1).

Erden
Das Gerät muss den örtlichen Vorschriften entsprechend geerdet werden. Die mitgelieferte Netzzuleitung enthält einen Schutzleiter und ist mit Schutzkontaktsteckern versehen. Hierdurch wird beim Anschluss an eine Schutzkontaktsteckdose das Gehäuse des Geräts zwangsläufig mit Schutzerde verbunden.

ACHTUNG: **Der Netzanschlussstecker darf nur in eine Schutzkontaktsteckdose eingeführt werden. Diese Schutzmassnahme darf nicht unwirksam gemacht werden, z.B. durch eine unvollkommene Verlängerungsleitung!**
Die Aussenkontakte der BNC-Eingangsbuchsen führen das Schaltungsnullpunkt-Potential und sind mit dem Gehäuse verbunden. Eine Schutzerdung über die Aussenkontakte der BNC-Eingangsbuchsen ist unzulässig!

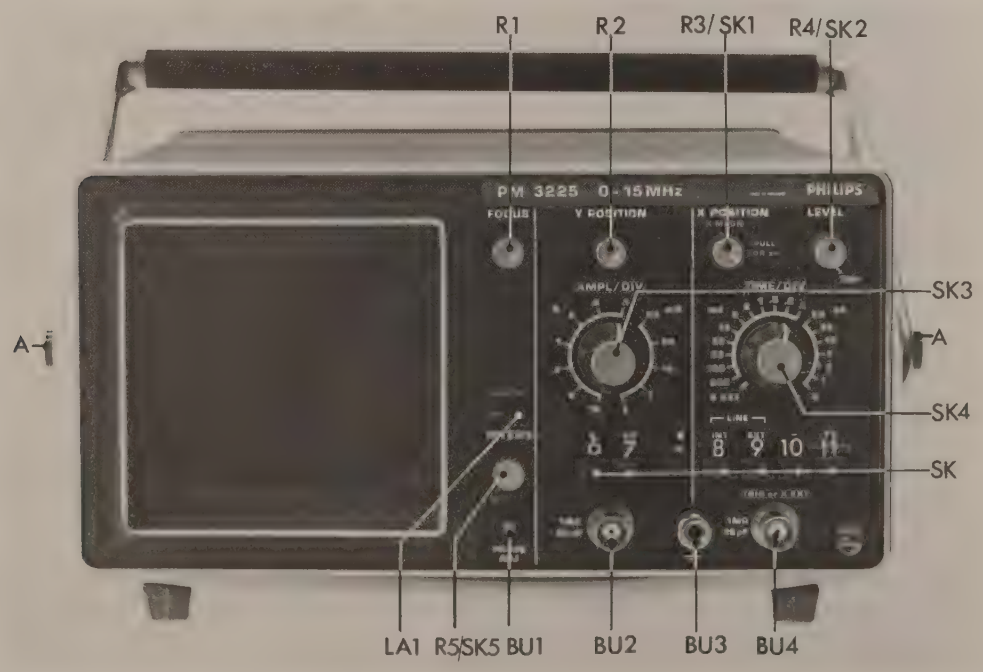


Abb. 2.2. Frontansicht mit Angabe der Bedienungsorgane

2.1.6 Bedienungsorgane und Buchsen (Abb. 2.2)

FOCUS (R1)	Stufenlos veränderliche Einstellung der Elektronenstrahl-Fokussierung.
Y POSITION (R2)	Stufenlos veränderliche Einstellung der vertikalen Lage der Darstellung.
X POSITION (R3) X MAGN (SK1)	Stufenlos veränderliche Einstellung der horizontalen Lage der Darstellung. Mit Schalter für kalibrierte fünffache Dehnung der Zeitablenkung.
LEVEL (R4) TOP (SK 1)	Stufenlos veränderliche Einstellung des Pegels, bei dem der Zeitablenkgenerator startet. Der Schalter ermöglicht eine TOP stellung für grosse impulsgeformte Signale.
AMPL/DIV (SK3)	Einstellung der vertikalen Ablenkkoeffizienten in 12 kalibrierten Stufen.
TIME/DIV (SK4)	Einstellung der Zeitmassstäbe der Zeitablenkung in 18 kalibrierten Stufen und einer Stellung für externe X-Ablenkung (X EXT).
POWER ON (LA1)	Leuchtet auf (rot), wenn das Gerät eingeschaltet ist.
INTENS (R5) mit Schalter OFF (SK5)	Stufenlos veränderliche Helligkeitseinstellung des Elektronenstrahls mit ON/OFF Schalter für die Speisung des Oszilloskops.
O Drucktaste (SK6)	Unterbricht den Y-Eingang und erdet die Eingangsschaltung.
AC-DC Drucktaste (SK4)	AC (gedrückt) Y-Eingang über Trennkondensator DC (ausgelöst) Y-Eingang direkt gekoppelt.
TRIGGERING, Drucktasten (SK8-SK11)	Einstellung von Triggerquelle, Flanke und Triggerart.
INT (SK8)	Internes Triggersignal von Kanal Y abgenommen.
EXT (SK9)	Triggerssignal abgenommen von einer an Buchse TRIG oder X EXT (BU4) gelegten Spannung.
LINE (SK8 + SK9 gleichzeitig betätigt)	Triggersignal von einer internen Spannung mit Netzfrequenz abgenommen.
± (SK10)	Triggerung auf positiv gerichtete Flanke, wenn Taste ausgelöst, auf die negativ gerichtete Flanke wenn Taste gedrückt.
TV NORMAL } (SK11)	Wenn gedrückt, Triggerung auf Zeilen — oder Bildimpulsen eines Fernsehsignals, je nach Stellung des Schalters TIME/DIV (SK4). Triggerung auf Bildimpulse in Stellungen .5 ms/div ... 200 ms/div. Triggerung auf Zeilenimpuls in Stellungen .2 ms/div ... .5 µs/div.
PROBE ADJ (BU1)	Ausgangsbuchse für Messkopf-Kalibrierung
1 MΩ//25 pF (BU2)	BNC-Eingangsbuchse für Vertikalablenksignal.
⏚ (BU3)	Schaltungsnullpunkt Erdungsbuchse (keine Schutzerde).
TRIG or EXT 1 MΩ//25 pF (BU4)	BNC-Eingangsbuchse für externe Triggersignale oder externe Zeitablenkung.

2.2 BEDIENUNG

2.2.1 Einschalten

Das Netzkabel ist um die vier Füsse des Geräts gewickelt. Nachdem der Oszilloskop gemäss den Abschnitten 2.11 bis 2.1.5. an des Netz angeschlossen wurde, kann er mit dem Bedienungsknopf INTENS gekoppelten Netzschalter eingeschaltet werden; die rote Lampe POWER ON leuchtet auf.

Der Oszilloskop wird die Spezifikationen (siehe Abschnitt 1.2) nach einer Anwärmzeit von erwa 15 Minuten erfüllen. Wenn das Gerät jedoch grosser Kälte ausgesetzt war (z.B. bei Temperaturen unter dem Gefrierpunkt), dann beträgt die Anwärmzeit mindestens 2 Stunden.

2.2.2 Grundeinstellungen der Bedienungsorgane

- Prüfen, ob die richtige Netzspannung eingestellt ist (wie in Abschnitt 2.1.5 angegeben).
- Das Gerät einschalten.
- Bedienungsknopf INTENS (R5) in Mittelstellung.
- Triggerquelle, Triggerflanke und Triggerart wählen, Wenn keine dieser Tasten betätigt wurden, triggert der Ozsilloskop automatisch und intern.
- Mit Hilfe von Knopf Y POSITION (R2) den Elektronenstrahl auf den Schirm schieben
  Das Gerät ist nun betriebsbereit.

2.2.3 Abgleich der Spannungsteiler-Messköpfe

Messkopfsätze PM 9326 und 9327

- Betriebsart LINE (Netz-Triggerung) (Drucktasten SK8 + SK9 gleichzeitig eindrücken) einstellen und eine Zeitablenklinie darstellen.
- Einsteller LEVEL ganz nach rechts drehen (Stellung TOP).
- Taste AC (SK7) eindrücken.
- Schalter AMPL/DIV (SK3) auf 5 mV/div stellen.
- Messkabel an Buchse BU2 anschliessen und die Messkopfspitze an Buchse BU1 legen (siehe Abb. 2.2).
- Entweder .5 ms/div oder .2 ms/div wählen.
- Die Verriegelungsschraube lösen und den "Messkopfkörper" (siehe Abb. 2.3) gegenüber dem Kabel so lange drehen, bis die richtige Einstellung erreicht ist.
- Die Verriegelungsschraube anziehen und sich überzeugen, dass die Einstellung unverändert ist.

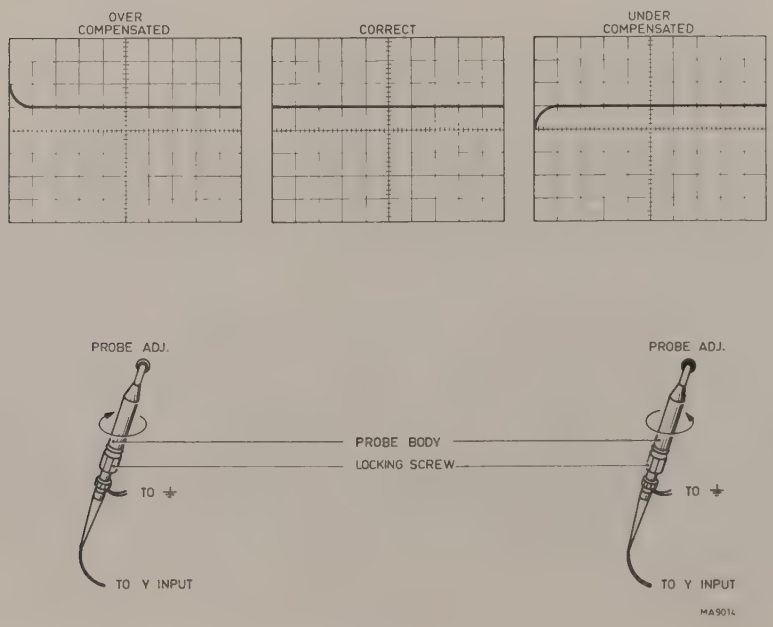


Abb. 2.3. Abgleich der Messköpfe PM 9326 und PM 9327

Messkopfsätze PM 9336, PM 9336L und PM 9358

- Betriebsart LINE (Drucktasten SK8 + SK9 gleichzeitig drücken) einstellen und eine Zeitablenklinie darstellen.
- Einsteller LEVEL ganz nach rechts drehen (Stellung TOP).
- Taste AC (SK7) eindrücken.
- Schalter AMPL/DIV (SK3) auf 5mV/div stellen.
- Die Kompensationsdose mit BU2 verbinden und die Messkopfspitze an BU1 legen (siehe Abb. 2.2).
- Entweder .5 ms/div oder .2 ms/div wählen.
- Mit einem kleinen Schraubenzieher durch die Öffnung der Kompensationdose den Trimmer so einstellen, dass eine richtige Darstellung erhalten wird (siehe Abb. 2.4).

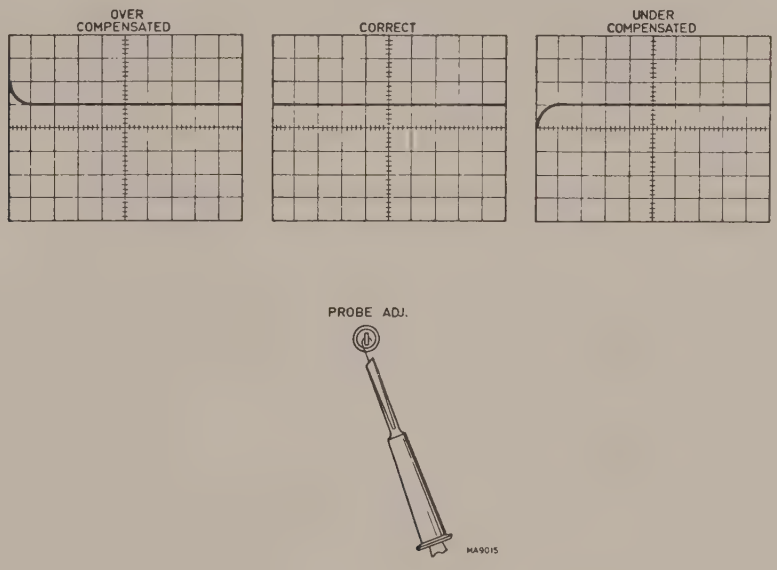


Abb. 2.4. Abgleich der Messköpfe PM 9336, PM 9336L und PM 9358

2.2.4 Eingangsfunktionen

Der PM 3225 besitzt einen Vertikalkanal, der entweder zusammen mit einem Zeitablenkgenerator für Y-T-Messungen bis 15 MHz, oder für X-Y-Messungen bis 100 kHz verwendet werden kann.

Y-T-Messungen

Ein eingangssignal an BU2 wird gegen den internen Zeitablenkgenerator über den Bereich des Schalters TIME/DIV (SK4) für Normalbetrieb (dass heisst nicht mit Schalter SK 4 in Stellung X EXT) dargestellt.

X-Y-Messungen

Wenn der Schalter TIME/DIV (SK4) in Stellung X EXT steht, ist der Zeitablenkgenerator ausgeschaltet. Ein externer Eingang an der Frontplattenbuchse TRIG or X EXT (BU4) ist nun mit dem Y-Verstärkerkanal verbunden: Ist der Schalter X MAGN PULL for x5 (SK1) betätigt sind in dieser Betriebsart X-Y-Messungen bis zu 100 kHz möglich.

Einfluss der 0 und AC-DC schalter

Die zu beobachtenden Signale sind an Eingangsbuchse BU2 zu legen. Je nach Zusammensetzung des Signals ist Schalter AC-DC entweder einzudrücken oder auszulösen. In Stellung DC ist der Eingang direkt an den Y-Verstärker gekoppelt. Da der Y-Verstärker gleichspannungsgekoppelt ist, ist die ganze Bandbreite des Gerätes verfügbar. Daher gelangt das vollständige Eingangssignal an de Ablenkplatten, das bedeutet, dass die Gleichspannungskomponenten als Strahlverschiebungen auf dem Schirm sichtbar werden.
Wenn kleine Wechselspannungssignale hohen Gleichspannungen überlagert sind, kann dies zu Schwierigkeiten führen. Um in solchen Fällen das Wechselspannungssignal sichtbar zu machen, ist stärkere Abschwächung nötig, wodurch auch das Wechselspannungssignal stark abgeschwächt wird. Wird jedoch Schalter SK7 in Stellung AC gebracht, dann wird ein Trennkondensator zwischen Eingangsbuchse und Y-Verstärker gelegt, wodurch die Gleichspannungen gesperrt aber auch die niedrigste Frequenzen unterdrückt oder abgeschwächt werden.

Bei Darstellung von Rechtecksignalen niedriger Frequenz, hat dies Dachschräge zur Folge.
Mit betätigter Drucktaste 0 ist es sofort möglich den Gleichspannungsnullpegel zu bestimmen. Die Verbindung zwischen Verstärkereingang und Eingangsbuchse ist unterbrochen und der Verstärkereingang geerdet.

2.2.5 Triggerung

Allgemeines
Um ein stillstehendes Bild zu erhalten muss die Horizontalablenkung immer an einem festen Punkt des Signals gestartet werden, Deshalb wird der Sweep-gating Multivibrator von einem kurzen Triggerimpuls gestartet, der in der Triggereinheit erzeugt und durch ein Signal gesteuert wird, dan einem vertikalen Eingangssignal, einer externen Quelle oder eine interne Netzspannung (Betriebsart LINE) entstammt.

Triggerpegel
Bei einem komplizierten Signal mit mehreren periodisch auftretenden, nicht identischen Spannungsformen, muss um ein stillstehendes Oszillogramm, zu erhalten die Zeitachse immer bei derselben Spannungsform gestartet werden, Dies ist möglich wenn irgendein Teil des Kurvenzuges eine abweichende Amplitude hat. Mit dem einsteller LEVEL lässt sich der Triggerpegel so einstellen, dass nur diese grössere Spannungsabweichung diesen Pegel überschreitet.
In Betriebsart TOP ist es möglich, viele Signale verschiedener Amplitude und Form abzubilden.

Automatische Schaltung
Der Oszilloskop arbeitet mit freilaufender Zeitbasis, wenn kein Signal vorhanden ist. Es bleibt daher am Schirm eine Zeitablenklinie sichtbar, die zum Nullpunktvergleich sehr nützlich ist.

Externe Triggerung
Bei Signalen mit stark Schwankender Amplitude kann extern eine Triggerung von einem Signal mit konstanter Amplitude und gleicher Frequenz angewandt werden, Noch wichtiger ist externe Triggerung bei komplexen Signalen und Impulsmustern die zu Doppelbildern führen könnten. Dies erübrigt eine Neueinstellung des Triggerpegels bei jeder Änderung des Eingangssignals. Das externe Eingangssignal wird an Buchse TRIG or X EXT (BU4) gelegt.

Triggerung mit Netzfrequenz (Betriebsart LINE)
In diesem Falle ist das Triggersignal eine Sinusspannung mit Netzfrequenz. Diese Triggerquelle ist zu verwenden wenn die Frequenz des zu beobachtenden Signals der Netzspannung entstammt.
So lässt sich z.B. die Brummkomponente eines Signals ermitteln, eindem auf diese Komponente getriggert wird.
Die Netztriggerung (LINE) wird durch gleichzeitiges Drücken der Drucktasten INT + EXT (SK8 + SK9) gewählt.

Triggerung mit Fernsehsignalen
Es ist möglich, mit Zeilen- oder Bildsynchronimpulsen von Fernsehsignalen zu triggern. In den Stellungen .5 ms/div bis 200 ms/div des Schalters TIME/DIV (SK4) wird auf die Bildsynchronimpulse und den Stellungen .2 ms/div bis .5 µs/div des Schalters SK4 auf die Zeilensynchronimpulse getriggert. Die Stellung des Schalters SK10 für die Triggerflanke muss der inversen Polarität des Videosignals entsprechen; das heisst, Minusstellung von SK10 für positives Signal und die Plusstellung von SK10 für ein negatives Videosignal.

2.2.6 Dehnung der Zeitablenkung

Die Dehnung der Zeitablenkung wird durch Ziehen des Schalters, der mit dem Bedienungsknopf X POSITION gekoppelt ist, eingestellt. Mit diesem Schalter in Stellung x5, ist ein 5x schnellerer Zeitmassstab eingestellt.
Der Zeitmassstab wird durch Teilen des eingestellten Wertes TIME/DIV durch 5 ermittelt.

2.3 AUSBAU DES GERÄTS

2.3.1 Allgemeines

Dieser Abschnitt behandelt das Ausbauverfahren zum Entfernen von Bauteilen im Zuge von Reparatur- und Wartungsarbeiten. Alle aus dem Oszilloskop entfernten Leiterplatten sind vor Beschädigung entsprechend zu schützen, und alle normalen Vorsichtmassnahmen beim Gebrauch von Werkzeugen sind zu beachten (Siehe auch Abschn. 2)
Beim Ausbau sind alle gelösten Drahtverbindungen mit Sorgfalt zu markieren, um sie beim Einbau wieder anschliessen zu können.
Es ist immer darauf zu achten, dass vor Abnahme irgendwelcher Deckel oder Platten das Gerät vom Netz getrennt ist.
Einschalten des Gerätes, wenn eine Leiterplatte entfernt wurde, oder wenn eine Leiterplatte innerhalb einer Minute nach dem Ausschalten herausgenommen wird, kann Beschädigung des Geräts verursachen.

2.3.2 Abnehmen der Abdeckhauben

Das Gerät ist durch drei Abdeckhauben geschütz: eine Front-Schutzhaube, einen Mantel mit Handgriff und eine Abdeckplatte für die Rückwand.
Die Frontschutzhaube ist anzubringen, bevor der Mantel entfernt werden soll.

Das Abnehmen geschieht wie folgt:
- den Handgriff von der Frontplatte wegschwenken, dazu sind die beiden Verriegelungsknöpfe A (siehe Abb. 2.2) zu drücken.
- das Gerät auf seiner Frontschutzhaube auf eine ebene Fläche stellen.
- die Schlitzschraube in der Mitte der rückwärtigen Abdeckplatte lösen (siehe Abb. 2.1).
- rückwärtige Abdeckplatte abnehmen.
- die Nylon-Durchführung aus dem Mantel herausschieben, um die Netzschnur freizulegen.
- den Mantel abziehen.
- um die Frontplatte zugänglich zu machen, das Gerät horizontal aufstellen und die Frontschutzhaube abziehen.
- das Hochspannungsteil wird zugänglich, wenn die Plastikschutzhaube aus den Löchern der Rückwand gelöst und nach vorne geschoben wird.

2.3.3 Abnahme des Bildröhrenrahmens und des Messrasters

- durch leichtes Drücken der linken Seite lässt sich der Rahmen herausschwenken (siehe Abb. 2.5).
- durch leichten Druck von vorne lassen sich Maske und Raster aus dem Rahmen nehmen.

Abb. 2.5. Abnahme des Bildröhrenrahmens und des Messrasters

2.3.4 Abnehmen der Textplatte

- Knopfdeckel der Einstellorgane AMPL/DIV, TIME/DIV und X POSITION abnehmen.
- Sechskantmutter und Schlitzmutter lösen und Knöpfe entfernen.
- Alle überigen Knöpfe abziehen.
- Die überigen Sechskantmuttern, mit denen die textplatte befestigt ist, lösen.
- Vorsichtig die Textplatte abnehmen.

2.3.5 Ausbau der Potentiometer FOCUS und INTENS/OFF

- Geräteabdeckhauben wie beschrieben abnehmen (siehe Abschnitt 2.3.2).
- Den entsprechenden Einstellknopf auf der Frontplatte abziehen.
- Nylonklemmen B (Abb. 2.6) durch die Öffnungen an der Rückwand herausschieben.
- gleichzeitig Achse C (Abb. 2.6) drehen und ziehen bis das viereckige Achsenende genau in die Öffnung passt und sich herausnehmen lässt.
- Plastikklemme und Achse entfernen.
- Sechskantmutter D (Abb. 2.6) lösen, um Potentiometer zu entfernen.

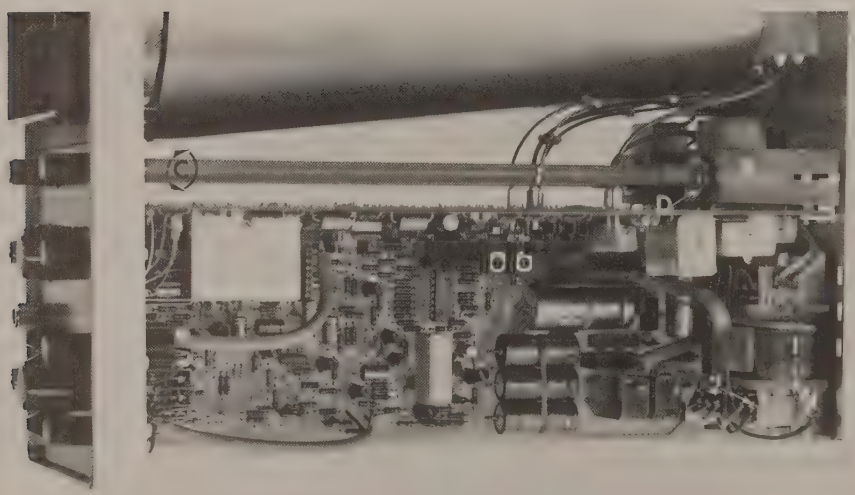


Fig. 2.6. Ausbau

2.3.6 Ausbau des Einschubs

- Abdeckhauben, wie angegeben abnehmen (siehe Abschnitt 2.3.2).
- Plastik-Schutzhaube aus den Rückwandlöchern lösen und nach vorne schieben.
- die beiden Stocko-Stecker und die freien Zuleitungsstecker entfernen.
  Beachten, dass auch die Verbindung der Messkopfeinstellung zur Frontplatte gelöst werden muss.
- vier Schrauben und eine Mutter von folgenden Stellen entfernen:
  - 3 Schrauben E (Abb. 2.7) mit denen die Leiterplatten an der Rückwand befestigt sind
  - 1 Schraube F (Abb. 2.7) hinter der Frontplatte (oben)
  - 1 Mutter G (Abb. 2.7) Frontplatte (unten).
- Einschub zusammen mit Textplatte und Knöpfen durch die Frontplatte herausnehmen.

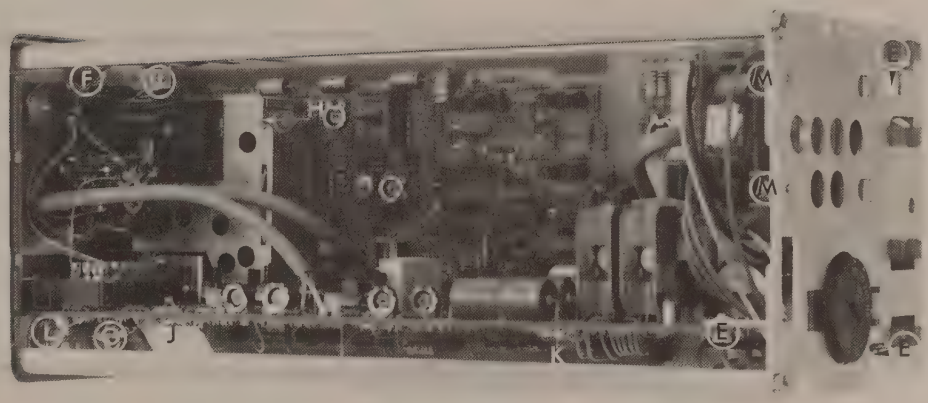


Abb. 2.7. Ausbau

2.3.7 Austausch des Abschwächerschalters

- elektronische Baugruppe gemäss 2.3.6 entfernen.
- die Abschirmplatte des Abschwächers durch Drücken der Fahne H am oberen Rand aushaken (siehe Abb. 2.7).
- mit einem Vakuum-Lötkolben die Drähte vom Abschwächer zur Printplatte von der Spurenseite ablöten.
- die beiden Schrauben J lösen (Abb. 2.7).
- Scharnier K in der Mitte des Leiterplatternrandes aushaken (Abb. 2.7).
- Textplatte und Sechskantmutter zur Befestigung des Abschwächers entfernen (siehe Abschnitt 2.3.4).

Den vorhandenen Schalter entfernen und durch einen neuen Schalter ersetzen.

2.3.8 Ausbau einer Printplatte

- Abeckhauben des Gerätes, wie angegeben entfernen siehe Abschnitt 2.3.2
- Abschirmplatte des Abschwächers, wie angegeben entfernen (siehe Abschnitt 2.3.7)
- die entsprechenden Verbindungen ablöten, Ihre Zuordnung merken.
- Scharnier K in der Mitte der Leiterplatte aushaken (Abb. 2.7).
- um die horizontale Platte auszubauen: Befestigungsschraube L an der Frontplatte lösen (Abb. 2.7).
- um die vertikale Platte auszubauen: die entsprechenden Abschwächerverbindungen und zwei Schrauben J an der Frontplatte entfernen (Abb. 2.7).

2.3.9 Ausbau des Netztranformators und der Thermosicherung

- Abdeckhauben des Gerätes, wie angegeben entfernen (siehe Abschnitt 2.3.2).
- Verbindungsdrähte ablöten ihre Lage merken.
- 6-poligen Stocko-Stecker entfernen.
- zwei Befestigungsschrauben M lösen (Abb. 2.7).
- Transformator seitwärts herausheben.

2.3.10 Ersatz der Thermosicherung (siehe auch Abschnitt 2.1.3)

- Abdeckhauben, wie angegeben abnehmen (Siehe Abschnitt 2.3.2).
- Sicherungsdrähte 1 und 2 ablöten (Siehe Abschnitt 2.13 und Abbschnitt 2.8).
- Defecte Sicherung entfernen; dazu ist der Sperrnocken freizulegen, indem man das im Trafowickel enthaltene Gehaüse der Thermosicherung an der Stirnseite etwas auswärts biegt.
- Auf die gleiche Weise wird eine neue Sicherung aus ihrem Gehaüse heraüsgenommen. Sie wird dann in das Gehäuse der alten Sicherung geschoben bis der Sperrnocken in der Öffnung einrastet, die Schleife ist Anschluss '1' zugewand.
- nach Anlöten der Anschlüsse "1" und "2" und Beseitigung der Überlastüngsürsachen ist das Gerät betriebsbereit.

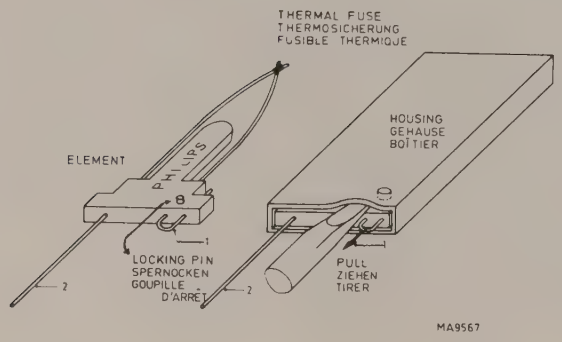


Abb. 2.8 Ersatz der Thermosicherung

2.3.11 Ausbau der Elektronenstrahlröhre

- Abdeckhauben des Geräts, wie angegeben entfernen (siehe Abschnitt 2.3.2).
- Schrauben N und P hinter der Frontplatte lösen (siehe Abb. 2.9).
- Bildröhrenrahmen entfernen (siehe Abschnitt 2.3.3).
- Plastik-Verriegelungsstück entfernen.
- die beiden Nylonklemmen Q (siehe Abb. 2.6) am Ende der Röhre nach innen pressen und unter Rücksichtnahme auf die Mumetallabschirmung die Elektronenstrahlröhre so weit durch die Frontplatte herausschieben, dass die Röhrenfassung gelöst werden kann (Nylonklemme zur Unterstützung zurückschieben).
- Klemmschraube R des Spannbands der Röhre lockern (Abb. 2.9).

Bemerkung: Bei Montage einer Elektronenstrahlröhre ist darauf zu achten , dass der Röhrenschirm an das Messraster liegt; die Klemmschraube darf nicht zu fest angezogen werden. (Schraubendrehmoment $\leqslant$ 40 Newton x cm).

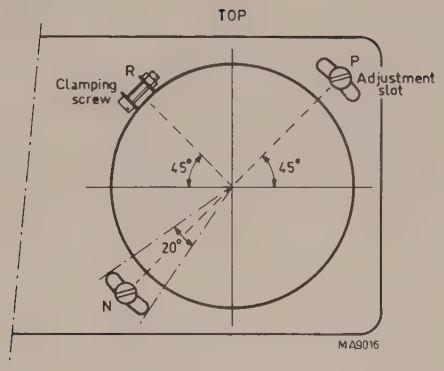


Abb. 2.9. Einstellung der Elektronenstrahlröhre

2.3.12 Abnehmen des Traggriffs

- Die beiden Kunststoffknöpfe des Traggriffs entfernen (z.B. mit einem Schraubenzieher).
- Schrauben entfernen.

2.3.13 Ersatz eines Drucktasten Schalter

- Die betreffende Leiterplatte wie in Abschnitt 2.3.8 beschrieben ausbauen.
- Die 4 Befestigungsfahnen des entsprechenden Schalters wie in Abb. 2.10 gezeigt, geradebiegen.
- Das betreffende Schaltergehäuse mit einer Zange zerbrechen und die Stücke herausholen. Die Lötstifte sind dan zugänglich.
- Die Lötstifte auslöten und die Löcher in der Leiterplatte reinigen (z.B. mit einem Sauglötkolben).
- Den neuen Schalter in die Leiterplatte einlöten
- Die 4 Befestigungsfahnen in ihre ursprüngliche Stellung zurückbiegen.

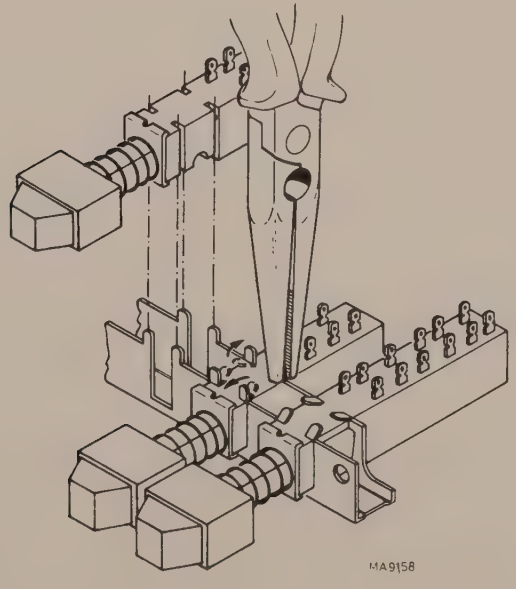
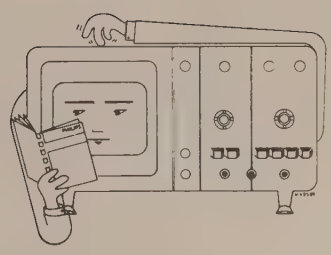


Abb. 2.10. Ersatz eines Drucktasten Schalters

Notice d'emploi

1. Généralités



1.1 INTRODUCTION

L'oscilloscope portatif 15 MHz PM 3225 est un appareil compact et léger au fonctionnement simple; il a été conçu à des fins de service, de recherche et d'enseignement.

L'appareil est pourvu d'un dispositif automatique permettant le déclenchement sur secteur ou sur les impulsions de synchronisation (ligne et trame) d'un signal télévision.

Le tube à rayons cathodiques présente une surface utile étalonnée de 8 x 10 divisions par graticule externe.

Tous les circuits sont entièrement transistorisés et montés sur des platines, ce qui facilite la maintenance.

Le dessin et la composition directes offrent, en plus d'un fonctionnement simple, un haut degré de fiabilité.

Fig. 1.1 Vue avant PM 3225

1.2. CARACTERISTIQUES TECHNIQUES

Instructions générales

Seules les valeurs indiquées avec tolérance sont garanties par l'usine. Les chiffres sans tolérance ne servent qu'à titre d'information et correspondent aux caractéristiques d'un appareil moyen.

Désignation	*Spécification*
1.2.1. Tube à rayons cathodiques	
Type	: D10 – 160 GH
Aire de mesure	: 8 x 10 divisions; 1 Div = 7,5 mm
Type d'écran	: P31 (GH) P7 (GM) en option
Tension d'accélération	: 1,5 kV
Graticule	: Externe, pas illuminé
1.2.2. Amplificateur vertical	
Gamme de fréquence	: continu 0 Hz à 15 MHz alternatif 2 Hz à 15 MHz
Temps de montée	: 25 ns
Dépassement	: $\leqslant$ 3 % (impulsion de test: amplitude 6 div, temps de montée 3 ns)
Coefficients de déviation	: 2 mV/div à 10 V/div en 12 échelons calibrés, en progression 1-2-5; précision ± 3 %
Tension d'entrée maxi admise	: ± 400 V (tension continue + tension alternative crête) Résiste à des crêtes non-répétitives jusqu'à 1000 V
Gamme de position verticale	: 16 divisions
Gamme dynamique	: 24 divisions pour signaux sinusoïdaux à fréquences allant jusqu'à 1 MHz 6 divisions pour signaux sinusoïdaux jusqu'à 15 MHz
Impédance d'entrée	: 1 MΩ//25 pF
1.2.3. Amplificateur horizontal	
Réponse	: continu à 100 kHz
Coefficients de déviation	: 5 V/div pour agrandissement x1; précision ± 15 % 1 V/div pour agrandissement x5
Tension d'entrée maxi admise	: ± 400 V (tension continue + tension alternative crête) Résiste à des crêtes non-répétitives jusqu'à 1000 V
Impédance d'entrée	: 1 MΩ//25 pF
Déphasage	: 5° à 50 kHz
1.2.4. Base de temps	
Coefficients de temps	: 0,2 sec/div à 0,5 µsec/div en 18 échelons étalonnés, en progression 1-2-5
Erreur de coefficient	: ± 5 %
Expansion	: x5, 1 échelon étalonné
Erreur supplémentaire	: 2 %

Désignation	*Spécification*

1.2.5. Déclenchement

Sourches	:	Interne Externe Secteur
Sensibilité de déclenchement	:	Interne ; déclenchement sur la valeur ajustée (LEVEL): ⩽ 0.75 div à 100 kHz 1.5 div. à 15 MHz déclenchement sur la valeur de crête (TOP): ⩽ 2 div. à 15 MHz déclenchement sur le signal télévision (TV): 0,5 div. pour impulsions de synchronisation de ligne ou de trame
		Externe : déclenchement sur la valeur ajustée (LEVEL): 0,75 V à 100 kHz 1,5 V à 15 MHz déclenchement sur la valeur de crête (TOP): ⩽ 2 V à 15 MHz déclenchement sur le signal télévision (TV): 0,5 V pour impulsions de synchronisation de ligne ou de trame
Impédance d'entrée	:	1 Mohm//25 pF
Tension d'entrée maxi admise	:	± 400 V (tension continue + tension alternative crête) Résiste aux crêtes non-répétitives jusqu'à 1000 V.
Mode de déclenchement	:	Le générateur de base tourne librement en l'absence de signal de déclenchement a. Niveau de déclenchement réglable sur 12 divisions ou 12 V. Fréquence à déclenchement inférieur pour ondes sinusoïdales = 10 Hz b. Crête (TOP)
Pente de déclenchement	:	+ ou −
Déclenchement par signaux télévision	:	Trame (couplé avec positions .5 ms/div à 200 ms/div) Ligne (couplé avec positions .2 ms/div à .5 μs/div)
Réglage de sonde	:	Point de contact (pour ajustage de sonde, voir section 2.2.3.).

1.2.6. Caractéristiques d'environment

Les données mentionnées sous CARACTERISTIQUES TECHNIQUES ne sont valables que si l'appareil est contrôlé conformément aux normes officielles. Des détails à ce sujet et sur les critères de défaillance sont disponibles sur demande à l'Organisation PHILIPS de votre pays, ou à N.V. PHILIPS' GLOEILAMPEN-FABRIEKEN, TEST AND MEASURING DEPT., EINDHOVEN, HOLLANDE.

1.2.6.1. Température

— Valeur de référence	:	23 °C
— Gamme nominale de travail	:	+5 °C à +40 °C
— Gamme limite de travail	:	−10 °C à +55 °C
— Gamme de stockage et de transport	:	−40 °C à +70 °C

1.2.6.2. Altitude

Limite opérationnelle	:	5000 m } à l'air libre
Limite de transport	:	15000 m }

1.2.6.3. Humidité : Répond aux normes CEI 60 Db.

1.2.6.4. Résistance aux chocs : 1000 chocs de 10 g, 1/2 sinusoïde, durée 6 ms, dans chacune des trois directions.

1.2.6.5. Résistance aux vibrations : 30 minutes dans chacune des trois directions, 10-150 Hz; 0,7 mm crête-à-crête et 5 g accélération maximale

1.2.6.6. Interférence électromagnétique : Répond aux normes VDE, Störgrad K

1.2.7. Position de fonctionnement : selon le choix

1.2.8. Tensions d'alimentation : 110 V, 127 V, 220 V et 240 V; en alternatif ± 10 % (46 Hz à 400 Hz)

Consommation : 18 VA

1.2.9. Caractéristiques mécaniques

Hauteur : 140 mm

Largeur : 260 mm

Longueur : 320 mm

Poids : 3,8 Kg.

1.2.10. Refroidissement : Par convexion naturelle

1.3. ACCESSOIRES

Accessoires livrés avec l'appareil :
- 1 couvercle frontal
- 1 adaptateur BNC-4 mm
- 1 notice d'emploi
- 1 plaque de contraste

Accessoires en option

PM 9326	Sonde passive 10 : 1 (1,1 m câble)
PM 9327	Sonde passive 10 : 1 (2,1 m câble)
PM 9335	Sonde passive 1 : 1 (1,5 m câble)
PM 9335L	Sonde passive 1 : 1 (2,5 m câble)
PM 9336	Sonde passive 10 : 1 (1,5 m câble)
PM 9336L	Sonde passive 10 : 1 (2,5 m câble)
PM 9358/01	Sonde passive 100 : 1 (1,5 m câble)
PM 9353	Sonde FET active 1 : 1, 1: 10, 1 : 100
PM 9355	Sonde de mesure des courants
PM 9346	Bloc d'alimentation pour des sondes actives
PM 9380	Appareil de photographie d'oscillogrammes
PM 8971	Adaptateur (oscilloscope – PM 9380)
PM 9051	Adaptateur BNC-4 mm

Croquis coté pour montage en rack 19" (Fig. 3.27)
Aérosol anti-statique
Jeu d'outils d'ajustage

Voir également chapitre 3.5. "Information concerning accessories".

1.4. DESCRIPTION DU SCHEMA SYNOPTIQUE (voir Fig. 1.2., page 12)

1.4.1. Voie Y

La voie verticale pour signal à représenter comprend un commutateur de couplage d'entrée, un atténuateur d'entrée, un étage d'entrée source-follower avec circuit de protection, un pré-amplificateur, un étage sélectif de déclenchement et un amplificateur de sortie.
Le circuit de protection de l'étage d'entrée est une diode évitant l'endommagement des transistors à effet de champ en cas de potentiels d'entrée négative excessifs, et un circuit à résistance protège l'étage d'entrée contre forts potentiels positifs.
Etant donné que les transistors de l'étage pré-amplificateur équilibré occupent les mêmes circuit intégrés, la stabilisation obtenue constitue une mesure de correction pour réduire la dérive dans les amplificateurs à forte amplification.
L'étage sélectif de déclenchement fournit un signal de déclenchement d'un côté du pré-amplificateur équilibré à l'amplificateur de déclenchement en cas de déclenchement interne.
Le signal de l'amplificateur de sortie équilibré est couplé directement aux plaques Y du t.r.c.

1.4.2. Déclenchement

Le signal de déclenchement peut être obtenu à partir de la voie d'amplificateur vertical (par l'intermédiaire de l'étage sélectif de déclenchement), d'une source externe ou internement par l'alimentation secteur (déclenchement LINE). Le signal de déclenchement est sélectionné et normalement appliqué, par l'intermédiaire de l'amplificateur, au conformateur d'impulsions, lequel alimente des impulsions bien définies au générateur de déverrouillage, en vue du démarrage du générateur de dents de scie.
Le déclenchement par signaux télévision (ligne et trame) est facilité par le séparateur de synchronsation et le détecteur de crêtes. Ce dernier étage est également mis en circuit en position TOP.

1.4.3. Base de temps

Le générateur de base de temps fonctionne selon le principe de l'intégrateur de courant constant.
Le générateur de déverrouillage, déclenché par des impulsions du différenciateur et du circuit automatique, démarre le générateur de dents de scie. De ce fait, des impulsions en dents de scie, dont la durée dépend de la position du commutateur TIME/DIV, sont appliquées à l'amplificateur de sortie X.
Une impulsion de porte est appliquée au générateur de déverrouillage en vue de la commande du t.r.c. pendant le balayage avant. De plus, cette impulsion est appliquée à une douille externe pour réglage de sonde, par l'intermédiaire d'un circuit à diode.

1.4.4. Voie X

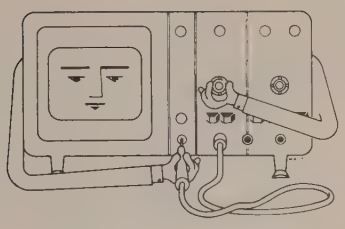
Par l'action du commutateur TIME/DIV (diode pilotée) l'amplificateur de sortie X reçoit son signal d'entrée du générateur de dents de scie ou d'une source externe (douille d'entrée X EXT par X et pré-amplificateur de déclenchement).
Le circuit X MAGN (x5) est incorporé à l'amplificateur de sortie X. La sortie de cet amplificateur est couplé directement aux plaques de déviation horizontale du t.r.c.

1.4.5. Circuit de t.r.c. et alimentations

Les hautes tensions pour t.r.c., lequel a un potentiel d'accélération de 1,5 kV, sont engendrées par un circuit multiplicateur de tension commandé par l'alimentation de puissance stabilisée. Le courant de faisceau t.r.c. est commandé par le réseau de potentiomètre INTENS par l'alimentation EHT et pendant le retour, par les impulsions de suppression provenant du générateur de dents de scie par l'intermédiaire de l'étage de suppression de faisceau.
La tension secteur d'entrée est réglée par un signal retourné d'une diode LED dans l'alimentation redressée +14 V.

Fig. 2.1 Vue arrière

2. Mode d'emploi



2.1 IMPORTANTES REGLES DE SECURITE

Le présente appareil quitte l'usine dans un état impeccable et répondant aux règles de sécurité. Dans cette optique et en vue d'un fonctionnement sans risque, nous vous recommandons de suivre à la lettre les instructions ci-après.

2.1.1 Tension secteur

L'appareil doit être branché à un secteur alternatif. A la livraison, l'appareil est réglé sur 220 V. En cas d'utilisation sur 110 V, 127 V ou 240 V, la tension appropriée doit être en mettant l'adaptateur à l'arrière sur la tension requise (voir Fig. 2.1.).

Avant usage
- Avant d'utiliser l'appareil après stockage et transport, vérifier s'il présente des dommages matériels (coffret, commandes, connecteurs, etc.).
- Vérifier si la tension réglée correspond à la tension secteur nominale.

Classe de protection
Le présent appareil répond à la classe de protection I (conducteur de terre) conforme à CEI 348 ou VDE 0411. Le cordon secteur compris à la livraison comporte une conducteur de terre. A moins qu'utilisé dans des endroits spécialement préparés (permis), la fiche secteur ne doit être introduite que dans une prise possédant un contact de terre.

2.1.2 Réparation et entretien

Erreurs et conditions spéciales
Au cas où le fonctionnement sans risque n'est plus garanti, l'appareil doit être mis hors service et protégé contre l'usage involontaire.

C'est le cas:
- lorsque l'appareil présente des dommages visibles
- lorsque l'appareil ne fonctionne plus
- lorsque les conditions (par ex. stockage, transport) dépasse les limites admises.

Ouverture de l'appareil
L'ouverture des capots ou la dépose d'organes, à l'exception de ceux directement accessibles à la main sont susceptibles de mettre à jour des composants et des connecteurs sous tension.

L'appareil doit débranché de toute source de tension avant de procéder à un réglage, un remplacement, une opération d'entretien ou une réparation demandant l'ouverture de l'appareil.

Au cas où le réglage, l'entretien ou la réparation de l'appareil ouvert sous tension sont inévitables, seule une personne qualifiée peut se charger de cette tâche.

Ne pas oublier que les condensateurs à l'intérieur de l'appareil peuvent être charges, même si l'appareil est déconnecté de toute source de tension.

Réparation et remplacement de pièces
Les réparations soivent se faire en compétence. Elles ne peuvent affecter la sécurité de l'appareil. Veiller surtout à ce que les distances d'air et de grimpement entre les pièces ne soient pas diminuées.
Pour le remplacement seules des pièces originales peuvent être utilisées. Des pièces différentes ne sont permises que si elles n'affectent pas la sécurité de l'appareil.

2.1.3 Fusibles

L'appareil est protégé contre les surcharges par un fusible thermique monté entre les enroulements du transformateur ou sur l'ailette de refroidissement du transistor TS 613. Ils peuvent être remplacés après dépose des couvercles de l'appareil (voir section 2.3.10).

Les fusibles spécifiés doivent être utilsés.

2.1.4 Position

L'appareil doit être placé horizontalement ou incliné après avoir pivoté l'étrier-support. Pour dépose le poignée, enfoncer les deux boutons centraux de pivotement A (voir Fig. 2.2.).

Les ouvertures de ventilation dans les plaques arrière et inférieure ne peuvent pas être recouvertes. Veiller à ne pas mettre l'appareil sur des objets produisant de la chaleur.

2.1.5 Installation (adaptation et connexion au secteur, mise à la terre)

Adaptation et connexion
L'appareil doit être branché au secteur alternatif. A la livraison, l'appareil est réglé sur 220 V. Avant de brancher l'appareil au secteur, vérifier si le transformateur de tension secteur est bien réglé sur la tension secteur locale (± 10%). La tension réglée est visible par une ouverture à l'arrière de l'appareil.

Pour régler l'appareil sur une autre tension secteur, procéder comme suit:
– déconnecter la fiche secteur
– régler la tension secteur par rotation du convertisseur de tension à l'arrière (voir Fig. 2.1.)

Mise à la terre
L'appareil doit être mis à la terre conformément aux règles de sécurité locales.
En cas de branchement à une prise murale à ergot de terre, le châssis est automatiquement relié à la terre par le câble secteur à trois conducteurs.

ATTENTION: **Toute interruption de la ligne de terre, à l'intérieur ou à l'extérieur de l'appareil ou le débranchement de la borne de terre peuvent rendre l'appareil dangereux. L'interruption intentionnelle est formellement interdite.**

Lorsqu'un appareil passe d'un endroit froid à un endroit chaud, la condensation peut provoquer un certain risque. En conséquence, il faut appliquer strictement les prescriptions de mise à la terre.

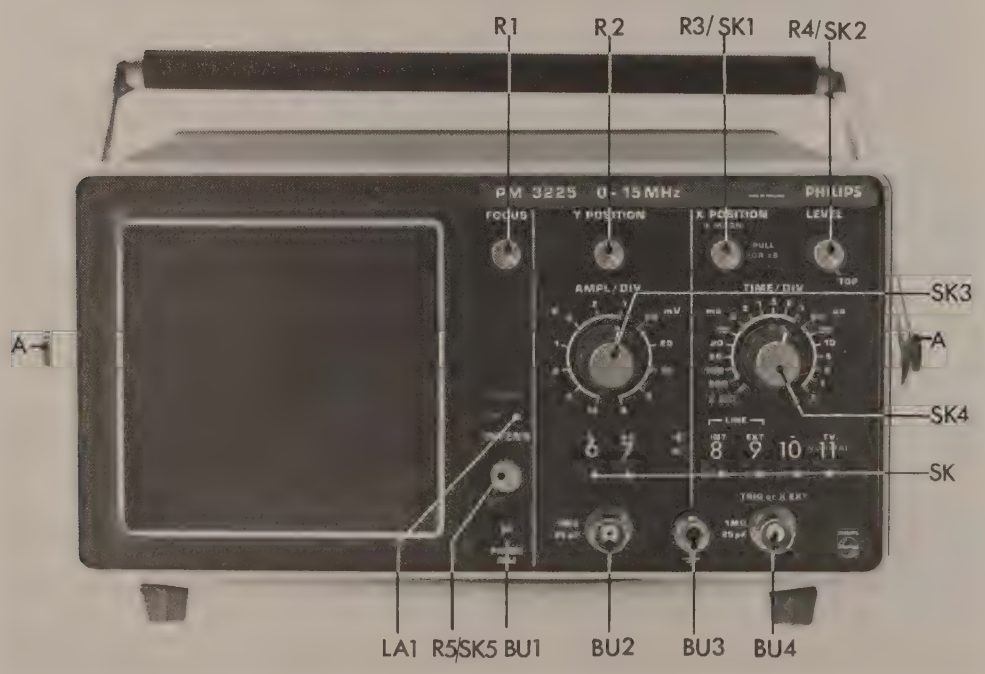


Fig. 2.2. Vue avant illustrant commandes et douilles

2.1.6 Commandes et douilles (Fig. 2.2)

FOCUS (R1)	Commande continuellement variable de focalisation du faisceau électronique.
Y POSITION (R2)	Commande continuellement variable indiquant la position verticale de l'affichage.
X POSITION (R3) X MAGN (SK1)	Commande continuellement variable indiquant la position horizontale de l'affichage. Elle comprend un commutateur pour agrandissement x5 étalonné de la base de temps.
LEVEL (R4) TOP (SK2)	Commande continuellement variable pour sélection du niveau où le générateur de base de temps dêmarre. Le commutateur a une position TOP pour grands signaux.
AMPL/DIV (SK3)	Commande pour coefficients de déviation verticale en 12 échelons étalonnés.
TIME/DIV (SK4)	Commande de coefficient de temps de la base de temps en 18 échelons étalonnés, plus une position pour déviation externe X (X EXT).
POWER ON (LA1)	S'allume (rouge) pour indiquer que l'appareil est enclenché.
INTENS (R5) avec commutateur OFF (SK5)	Commande continuellement variable de la luminosité de trace; comporte le commutateur ON/OFF pour alimentation de l'oscilloscope.
Bouton-poussoir 0 (SK6)	Interrompt la connexion d'entrée Y et met le circuit d'entrée à la terre.
Bouton-poussoir AC-DC (SK7)	AC (enfoncé) : entrée Y par condensateur de couplage DC (relâché) : entrée Y directement couplée.
Boutons-poussoirs TRIGGERING (SK8-SK11)	Commandes pour source, pente et mode de déclenchement.
INT (SK8)	Signal de déclenchement interne dérivé de la voie Y.
EXT (SK9)	Signal de déclenchement dérivé d'une tension appliqué à la douille TRIG ou X EXT (BU4).
LINE (SK8 + SK9 sélectionnés simultanément)	Signal de déclenchement dérivé d'une tension interne à fréquence secteur.
± (SK10)	Produit le déclenchement sur la pente positive du signal (position relâchée) et sur la pente négative (position enfoncée).
TV NORMAL } (SK11)	Enfoncé, il permet le déclenchement sur impulsions (ligne ou trame) de signaux télévision conformément à la position du commutateur TIME/DIV SK4. Déclenchement sur impulsions de trame en positions .5 ms/div à 200 ms/div. Déclenchement sur impulsions de ligne en positions .2 ms/div à .5 µs/div.
PROBE ADJ (BU1)	Borne de sortie pour sondes et test d'étalonnage.
1 MΩ//25 pF (BU2)	Douille BNC d'entrée pour signal de déviation verticale.
⏚ (BU3)	Douille de terre.
TRIG ou X EXT 1 MΩ// 25 pF (BU4)	Douille BNC d'entrée pour signaux de déclenchement externe ou déviation X externe.

2.2 MANIPULATION

2.2.1 Enclenchement de l'appareil

Le cordon secteur est enroulé autour des quatre pieds d'appareil. Après son branchement au secteur conformément à la section 2.1.5., l'oscilloscope peut être enclenché à l'aide de l'interrupteur secteur incorporé dans la commande INTENS; la lampe rouge POWER ON s'allume.

L'appareil répond aux specifications (voir section 1.2) après une période de chauffage d'environ 15 minutes. Cependant, si l'appareil est laissé dans un endroit extrêmement froid (par exemple une nuit dans une voiture alors qu'il gèle) et qu'ensuite on le place dans une pièce chauffée, une période de chauffage d'environ 2 heures doit être observée.

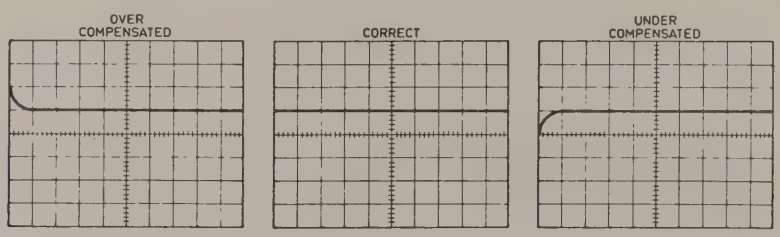
2.2.2 Réglages préliminaires des commandes

- Vérifier si la tension secteur correcte est choisie conformément à la section 2.1.5.
  Enclencher l'appareil.
- Mettre la commande R5 INTENS en position médiane.
- Choisir source, mode et pente de déclenchement. Si aucun bouton de déclenchement n'est choisi, l'oscilloscope déclenche en mode automatique et interne.
- Représenter la trace à l'aide de la commande Y POSITION R2.
  L'appareil est alors prêt à l'usage.

2.2.3 Réglage des sondes atténuatrices

Sondes PM 9326 et PM 9327

- Représenter une ligne de base de temps en choisissant le mode LINE (enfoncer simultanément les boutons-poussoirs SK8 et SK9).
- Tourner le potentiomètre LEVEL complètement vers la droite (position TOP).
- Enfoncer le bouton-poussoir SK7; choisir AC par exemple.
- Mettre le commutateur AMPL/DIV SK3 sur 5 mV/div.
- Connecter le fil de mesure à la douille BU2 et placer l'extrémité de sonde sur BU1 (voir Fig. 2.2).
- Choisir .5 ms/div ou .2 ms/div.
- Dèsserrer la vis de serrage et tourner le corps de sonde (voir Fig. 2.3) par rapport au câble jusqu'à ce que le réglage correct soit obtenu.
- Fixer la vis de serrage tout en s'assurant que le réglage n'est pas modifié.



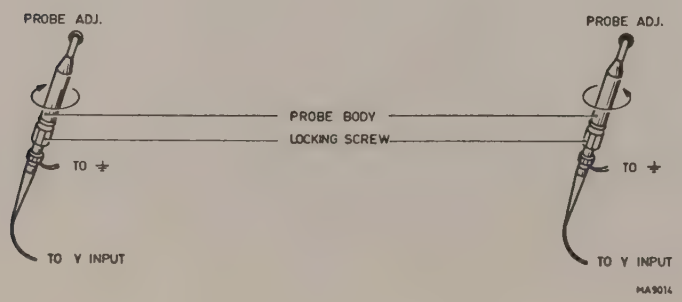


Fig. 2.3 Réglage des sondes PM 9326 et PM 9327

Sondes PM 9336, PM 9336L et PM 9358

- Représenter une ligne de base de temps en sélectionnant le mode LINE (enfoncer les boutons-poussoirs SK8 et SK9 simultanément).
- Tourner le potentiomètre LEVEL complètement vers la droite (position TOP).
- Mettre le commutateur AMPL/DIV SK3 sur 5 mV/div.
- Connecter la boite de compensation à BU2 et placer l'extrémité de sonde sur BU1 (voir Fig. 2.2).
- Choisir .5 ms/div ou .2 ms/div.
- Introduire un petit tournevis dans l'ouverture de la boîte de compensation; régler ainsi le trimmer afin d'obtenir une représentation correcte comme ilustré à la figure 2.4.

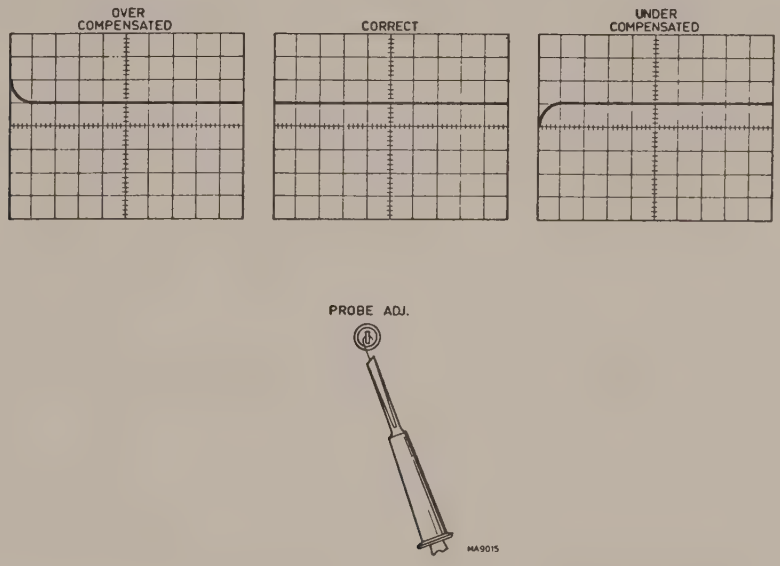


Fig. 2.4 Réglage des sondes PM 9336, PM 9336L et PM 9358

2.2.4 Fonctions d'entrée

Le PM 3225 est pourvu d'une voie verticale, laquelle peut être utilisée soit pour des mesures YT combiné avec le générateur de base de temps, soit pour des mesures XY jusqu'à des fréquences de 100 kHz.

Mesures YT

Un signal d'entrée sur BU2 est représenté par rapport au signal produit par le générateur de base de temps interne, sur la gamme du commutateur TIME/DIV SK4 en fonctionnement normal (pas en position X EXT de SK 4).

Mesures XY

Lorsque le commutateur TIME/DIV SK4 est mis sur X EXT, la base de temps est mise hors circuit. Une entrée externe sur la douille TRIG ou X EXT BU4 (panneau avant) est alors connectée à la voie amplificateur X. Le commutateur X MAGN SK1, PULL FOR x5 (panneau avant) est disponible. Dans ce mode, les mesures XY peuvent être effectuées jusqu'à 100 kHz.

Influence des commutateurs 0 et AC-DC

Les signaux à étudier peuvent être appliqués à la douille d'entrée BU2. En fonction du signal, le commutateur AC-DC doit être enfoncé ou relâché. En position DC, l'entrée est couplée directement à l'amplificateur Y. Etant donné que l'amplificateur Y est couplé directement, la largeur de bande totale de l'appareil est disponible. A cet effect, les tensions d'entrée complètes sont appliquées aux plaques de déviation, ce qui signifie que les composants continus donnent des décalages de trace sur l'écran.
Ceci cause des problèmes lorsque des signaux alternatifs superposés à de hautes tensions continues doivent être représentés.
Pour visualiser le signal alternatif dans ce cas, il faudra une forte atténuation de sorte que le signal alternatif

sera fortement atténué.
Cependant, en position AC de SK7, un condensateur de blocage est connecté entre la douille d'entrée et l'amplificateur Y. De ce fait, les tensions continues sont bloquées, mais les fréquences inférieures sont également supprimées ou atténuées. Lorsque des signaux sinuoïdaux à basse fréquence sont représentés, ce qui donne une certaine pente de toit.
En choisissant le bouton-poussoir 0, il est possible de déterminer le niveau continu zéro volt. La connexion entre l'entrée amplificateur et la douille d'entrée est interrompue, l'entrée amplificateur étant mise à la terre.

2.2.5 Déclenchement

Généralités
Pour obtenir une trace stationnaire, la déviation horizontale doit toujours être démarrée à point fixe du signal. A cet effet, le générateur de déverrouillage est démarré par d'étroites impulsions formées dans l'unité commandées par un signal; ce dernier peut provenir d'un signal d'entrée vertical, d'une source externe ou d'impulsions secteur internes (en mode LINE).

Niveau de déclenchement
En cas de signal compliqué présentant périodiquement des formes de tension différentes, l'axe de temps doit toujours être démarré par la même forme de tension afin d'obtenir une trace stationnaire. Ceci est possible lorsqu'un des détails présente une amplitude différente. La commande LEVEL permet de régler le niveau de déclenchement de telle sorte que seule cette forte variation de tension dépasse ce niveau. En mode TOP il est possible de représenter une grande variété d'ondes d'amplitude et de forme différentes.

Circuit automatique
Lorsqu'il n'y a pas de signal, l'oscilloscope fonctionne en mode de déclenchement libre. A cet effet, une ligne de base de temps est visible sur l'écran lorsqu'il n'y a pas de signal de déclenchement. On obtient ainsi une indication de référence de zéro utile.

Déclenchement externe
Au cas où des signaux varient fortement en amplitude, le dèclenchement externe peut être appliqué à partir d'un signal d'amplitude constante et de fréquence équivalente. Le déclenchement externe est encore plus important là où des signaux et des impulsions complexes peuvent constituer des doubles traces. Dans ce cas, il n'est pas nécessaire de rajuster le niveau à chaque variation du signal d'entrée. Le signal d'entrée externe est appliqué à la douille TRIG ou X EXT (BU4).

Déclenchement avec fréquence secteur (mode LINE)
Le signal de déclenchement est une sinusoide de fréquence secteur. Cette source de déclenchement est utile lorsque la fréquence du signal observé est derivée de l'alimentation secteur. Par exemple, il est possible de déterminer le composant de bruit d'un signal en déclenchant sur ce composant.
La possibilité de déclenchement secteur (LINE) est obtenue en enfonçant les boutons-poussoirs (SK8 + SK9). INT + EXT simultanément.

Déclenchement avec signaux télévision
Il est possible de déclencher sur les impulsions de synchronisation (ligne ou trame) de signaux télévision. En position .5 ms/div à 200 ms/div du commutateur TIME/DIV SK4, le déclenchement se fait sur les impulsions de trame, tandis qu'en positions .2 ms/div à .5 µs/div de SK4 il se fait sur les impulsions de ligne.
La position du commutateur de pente de déclenchement SK10 doit correspondre à la polarité inverse de l'information vidéo du signal; par ex. position – de SK10 pour signal positif, position + pour signal vidéo négatif.

2.2.6 Agrandisseur de base de temps

L'agrandisseur est actionné en tirant le commutateur incorporé dans la commande de position X.
En position x5 de ce commutateur, la vitesse de balayage de la base de temps est agrandie 5 fois. Le temps de bayalage peut alors être déterminé en divisant la valeur TIME/DIV indiquée par 5.

2.3 DEMONTAGE DE L'APPAREIL

2.3.1 Généralités

La présente section décrit les procédés de démontage requis à la dépose des composants en cours de réparation et de maintenance de routine. Toutes les platines extraites de l'oscilloscope doivent être protégées contre tout dommage. De plus les précautions d'usage doivent être observées quant à l'utilisation des outils. (Voir aussi chapitre 2.) Pendant le démontage il faut prendre consciencieusement note des fils déconnectés afin d'éviter toute erreur lors du montage.

Toujours s'assurer que l'appareil est débranché avant de déposer les couvercles et plaques de l'appareil.

L'enclenchement de l'appareil peut causer son endommagement si une platine a été déposée ou encore si une platine a été déposée dans la minute suivant la mise hors service de l'appareil.

2.3.2 Dépose des couvercles

L'appareil est protégé par trois couvercles: un couvercle de protection à l'avant, une enveloppe avec poignée et une plaque arrière.
Pour faciliter la dépose de l'enveloppe et la plaque arrière, s'assurer d'abord que le couvercle avant est bien en position.

Procéder comme suit:
- pivoter la poignée du couvercle avant. Pour ce faire, enfoncer les deux boutons A (voir Fig. 2.2).
- Placer l'appareil avec couvercle frontal sur une surface plane.
- Desserrer la vis centre de la plaque arrière (voir Fig. 2.1).
- Enlever la plaque arrière.
- Enlever le presse-étoupe de l'enveloppe afin de libérer le cordon secteur.
- Soulever l'enveloppe.
- Pour accéder au panneau avant, mettre l'appareil en position horizontale et déboîter le couvercle frontal.
- Pour accéder à la partie haute tension, coulisser le couvercle protecteur transparent qui est fixé dans le panneau arrière vers l'avant.

2.3.3 Dépose de la visière et du graticule

Pour deposer la visière, tourner en appliquant un légère pression sur le flanc gauche (voir Fig. 2.5.).
La masque et le graticule peuvent tous deux être deboîtés de la visière en exerçant une légère pression de l'avant.

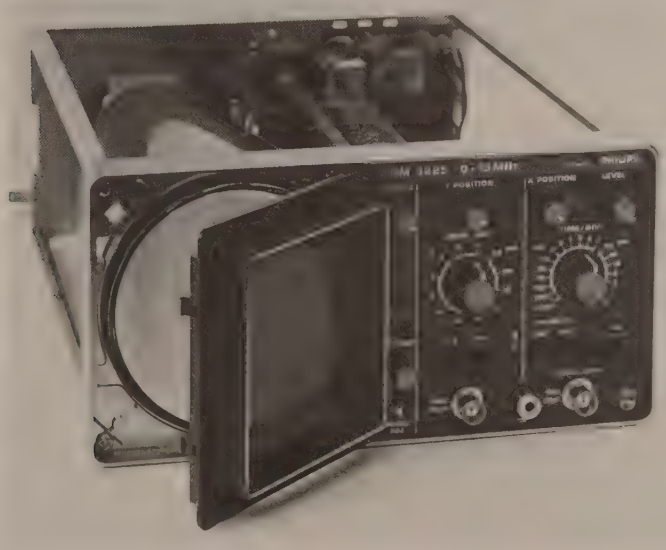


Fig. 2.5. Dépose de la visière et du graticule

2.3.4 Dépose de la plaque de texte

- Déposer les capots des commandes AMPL/DIV, TIME/DIV et X POSITION.
- Dévisser les écrous hexagonaux et l'écrou à encoche; déposer les boutons.
- Déposer les autres boutons par traction.
- Dévisser les autres écrous hexagonaux fixant la plaque de texte.
- Déposer avec soin la plaque de texte.

2.3.5 Dépose des commandes FOCUS et INTENS/OFF

- Enlever les couvercles d'appareil comme décrit à la section 2.3.2.
- Déposer le bouton de commande (panneau avant) approprié.
- Faire sauter les étriers de nylon B (Fig. 2.6) par les trous du panneau arrière.
- Tourner et tirer simultanément l'axe C (Fig. 2.6) jusqu'à ce son extrémité soit aligné avec trou (comme une clé).
- Déposer l'étrier plastique et l'axe.
- Dévisser l'écrou hexogonal D (Fig. 2.6) afin de déposer le potentiomètre.

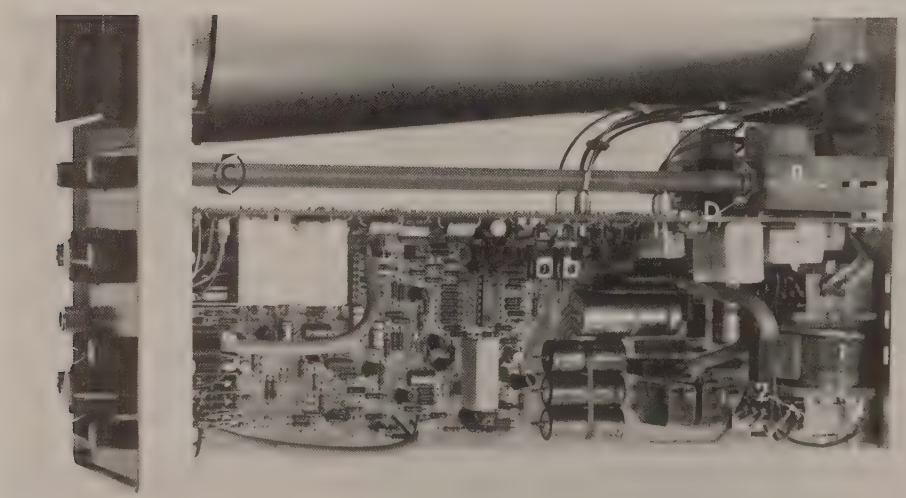


Fig. 2.6. Démontage

2.3.6 Dépose de l'ensemble électronique

- Déposer les couvercles d'appareil comme décrit à la section 2.3.2.
- Coulisser le couvercle protecteur transparent qui est fixé dans le panneau arrière vers l'avant.
- Enlever les connecteurs Stocko et les connexions volantes.
  A noter que le fil de réglage de sonde au panneau avant doit également être déposé.
- Déposer les quatre vis et un écrou dans l'orde suivant;
  - 3 vis E (Fig. 2.7) maintenant les platines sur le panneau arrière.
  - 1 vis F (Fig. 2.7) derrière le panneau avant (au-dessus).
  - 1 écrou G (Fig. 2.7) derrière le panneau avant (au-dessous).
- Extraire l'unité électronique entière par l'avant avec plaque de texte et boutons.

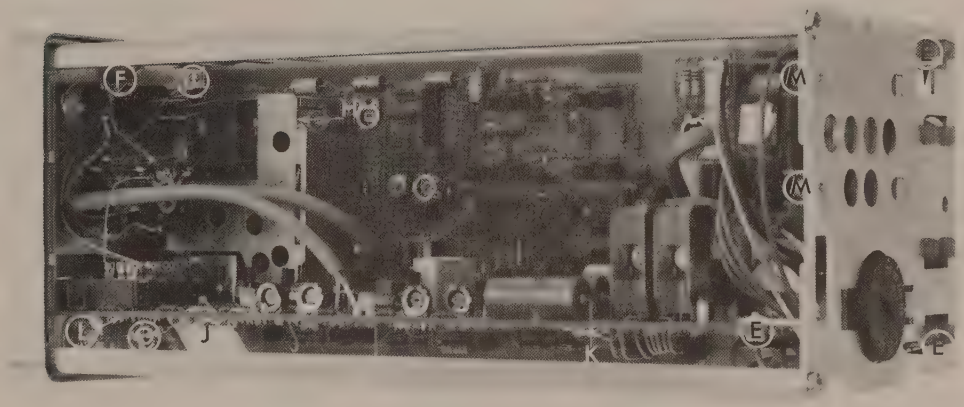


Fig. 2.7. Démontage

2.3.7 Accès à l'unité atténuatrice en vue du remplacement

- Déposer l'unité électronique conformément à 2.3.6.
- Déboîter le couvercle de blindage de l'atténuateur en enfonçant la cosse (H) sur le flanc supérieur (voir Fig. 2.7).
- Dessouder les fils vers platine d'atténuateur côté piste à l'aide d'un fer à souder aspirateur.
- Dévisser les deux écrous J (Fig. 2.7).
- Déboîter l'etrier K placé à mi-chemin le long de la platine (Fig. 2.7).
- Déposer la plaque de texte et le écrous hexagonaux fixant l'atténuateur (voir Section 2.3.4).

En cas de remplacement, enlever le commutateur et réaliser des connexions identiques sur le noveau commutateur.

2.3.8 Dépose d'une platine

- Enlever les couvercles d'instrument comme dècrit à la section 2.3.2.
- Enlever le couvercle de blindage d'atténuateur comme décrit à la section 2.3.7.
- Dessouder les connexions appropriées.
- Déboîter l'étrier K placé à mi-chemin le long de la platine (Fig. 2.7.).
- Pour déposer une platine horizontale: enlever une vis L fixant le panneau avant (Fig. 2.7.).
- Pour déposer une platine verticale: enlever les connexions d'atténuateur appropriées ainsi que les deux vis J la fixant au panneau avant (Fig. 2.7).

2.3.9 Dépose du transformateur secteur

- Enlever les couvercles d'appareil comme décrit à la section 2.3.2.
- Dessouder les fils de connexion, noter les positions.
- Enlever le connecteur Stocko à 6 voies.
- Dévisser les deux écrous de montage M (Fig. 2.7).
- Soulever le transformateur latéralement.

2.3.10 Remplacement du fusible

- Enlever les couvercles d'appareil comme dècrit à la section 2.3.2.
- Dessouder les bornes thermiques 1 et 2 (voir section 2.1.3 et Fig. 2.8).
- Enlever le fusible; à cet effet, recourber légèrement le boîtier vers l'extérieur de sorte que la goupille d'arrêt soit dégagée.
- Un nouveau fusible est déposé de son boîtier de la même façon que décrit ci-avant. Il est placé dans le même boîtier que l'ancien jusqu'à ce que la goupille d'arrêt s'adapte dans le trou avec un déclic, la cosse pointant vers la borne "1".
- Après soudage des bornes "1" et "2", l'appareil peut être considéré comme prêt à l'usage.

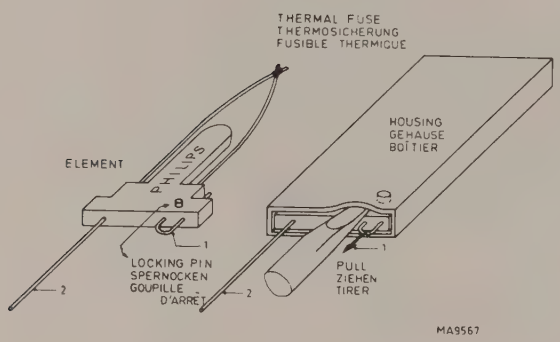


Fig. 2.8. Remplacement du fusible

2.3.11 Dépose du t.r.c.

- Enlever les couvercles d'appareil comme décrit à la section 2.3.2.
- Enlever les vis N et P derrière le panneau avant (voir Fig. 2.9).
- Enlever la visière (voir section 2.3.3).
- Enlever la pièce de blocage plastique.
- Faire sauter les deux cosses nylon Q (voir Fig. 2.6) arrière du tube, vers l'intérieur et tout en prêtant une attention particulière à l'écran mumétal faire passer le t.r.c. par le panneau avant suffisamment que pour permettre la dépose du connecteur de base (pousser sur l'étrier nylon le cas échéant).
- Desserrer la vis de blocage R dans l'étrier autour de la face de tube (Fig. 2.9).

Remarque: Lors de montage du t.r.c. bien régler la face de tube contre le graticule. De plus, veiller à ne pas serrer trop fort la vis R (pression de vis $\leqslant$ 40 newton x cm).

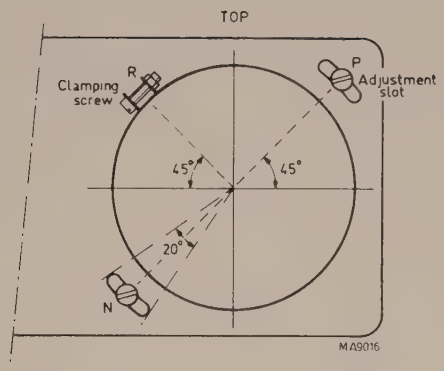


Fig. 2.9. Positionnement du t.r.c.

2.3.12 Dépose de la poignée

- Enlever les boutons de plastique de chaque pivot à l'aide d'un tournevis.
- Déposer les vis.

2.3.13 Remplacement d'un commutateur bouton-poussoir

- Déposer l'unité en question conformément aux données de la section 2.3.8.
- Redresser les 4 pattes de fixation du commutateur correspondant (voir Fig. 2.10)
- Casser le corps du commutateur avec une pince et extraire les composants. Les cosses à souder sont alors accessibles.
- Exstraire les cosses à soudure et nettoyer les trous dans la platine imprimée. (par exemple avec un fer à souder à aspiration).
- Souder le nouveau commutateur sur la platine imprimée.
- Courber les quatre boucles de retenue en position originale.

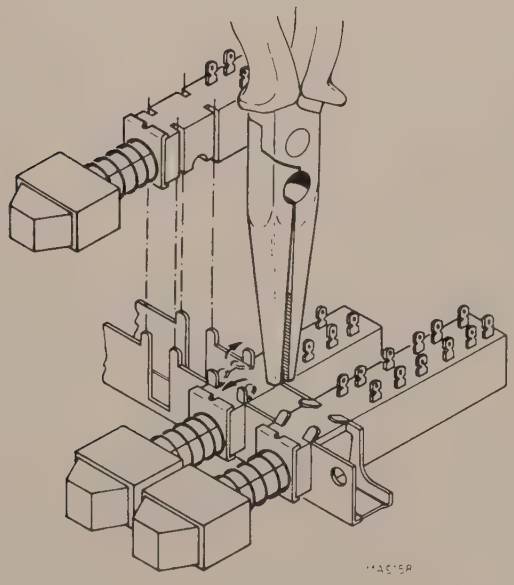


Fig. 2.10. Remplacement d'un commutateur bouton-poussoir

Service data

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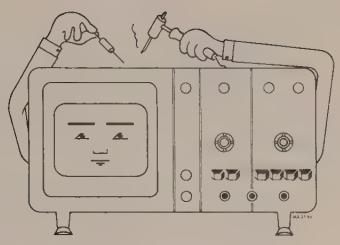
3. Service data



3.1 CIRCUIT DESCRIPTION

3.1.1 Vertical Deflection System

As shown in Fig. 3.1., the vertical deflection system (Y channel) feeds the Y input signal via a coupling mode switch, an attenuator, an input stage and a preamplifier to the final amplifier that feeds the Y deflection plates of the cathode-ray tube. The individual stages of the vertical deflection system are now described in some detail.

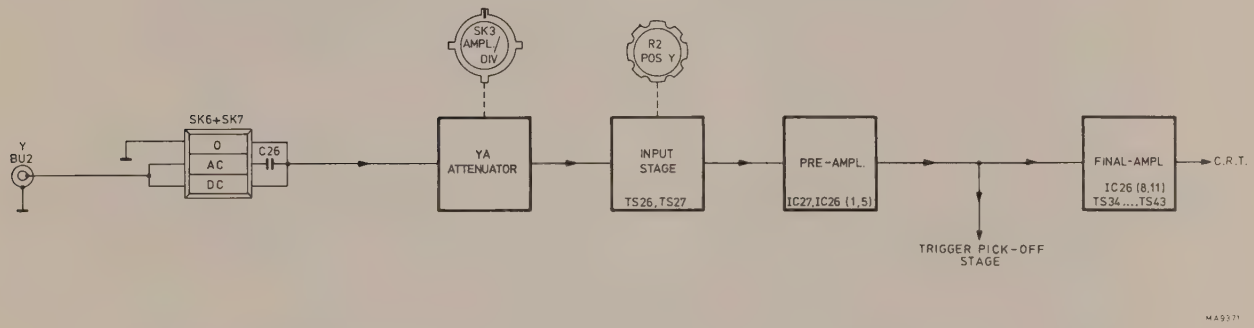


Fig. 3.1. Vertical deflection system

3.1.1.1 Input attenuator

The vertical channel input at socket BU2 is fed via the coupling mode components to two high-ohmic divider stages in cascade, which can be switched into circuit, if necessary, to provide the required amount of signal attenuation.

By means of the front-panel pushbutton SK7 (AC/DC) the input signal is applied either via capacitor C26 or direct. Pushbutton SK6 (0) isolates the Y input signal and earths the channel input for reference purposes; e.g. for calibration or centring the trace. The overall attenuation of the stage is determined by the combination of the selected sections of both voltage dividers. The various combinations are selected by the 12 positions of the front-panel AMPL/DIV attenuator switch SK3. The first divider stage incorporates a through-switching position, and two RC pi-networks that attenuate by factors of x 2.5 and x5. The second divider stage also incorporates a through-switching position, and three RC pi-networks that attenuate by factors of x 10, x 100 and x 1000. In combination, the two step-attenuator stages provide twelve Y deflection coefficients from 2mV/div to 10 V/div in a 2-5-10 sequence.

Equalisation of the input capacitance for the five attenuator networks is achieved by trimmers C28, C33, C38, C43 and C48. The voltage divider sections are made independent of the input frequency over the frequency range of the oscilloscope (i.e. 15 MHz) by means of trimmers C31, C36, C37 and C47.

3.1.1.2 Input stage

The input stage comprises two balanced field-effect transistors TS26 and TS27 in an impedance converter circuit. Diodes GR26 and GR27 protect the input source-follower against excessive negative input voltage swings; the input resistive network protects against excessive positive voltages. Vertical movement of the trace is provided by front-panel Y POSITION potentiometer R2 connected to the gate of field-effect transistor TS27. Preset potentiometer R46 serves to adjust the range of the POSITION potentiometer R2 to compensate for differences in the field-effect characteristics of TS26 and TS27.

3.1.1.3 Preamplifier

Note: Transistors forming part of integrated circuits are referred to by their collector points.

The balanced preamplifier stage, formed by integrated circuits, part of IC26 and IC27, is of the series-shunt feedback type. Since both halves of the amplifier are contained in the same integrated circuit blocks, the gain is independent of frequency and drift; i.e. two signals in the same phase cancel out. The Darlington pair input stages are fed from a constant-current source and direct coupling is employed throughout. The voltage gain at the IC26 collectors 1 and 5 is independent of the active components and is approximately equal to the ratio of the feedback resistance to the emitter resistances; i.e.

$$\text{Gain} = \frac{\text{shunt feedback resistance}}{\text{series feedback resistance}} = \frac{Rf}{Re} = \frac{R63 + R66}{R59 + R61 + \text{mutual conductance}}$$

Note: Most of the amplifier stages used in the PM 3225 are amplifiers with series and shunt feedback (Cherry-Hooper). A typical example of such an amplifier is shown below.

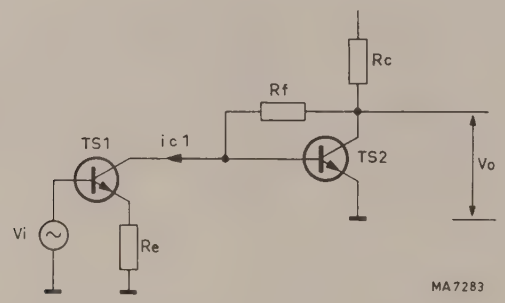


Fig. 3.2. Amplifier with series and shunt feedback

If we neglect the base current of TS2, it will be clear that the current through R_e also flows through R_f.
The transfer ratio $\frac{i_c}{v_i}$ in a series feedback amplifier stage is approximately $\frac{1}{R_e}$
The transfer ratio $\frac{v_o}{i_c}$ in a shunt feedback amplifier stage is approximately R_f.
Thus, the voltage gain of the whole amplifier $A_v = \frac{v_o}{v_i}$ is approximately $\frac{R_f}{R_e}$ and depends only on the passive elements R_f and R_e.

3.1.1.4 Final Y amplifier

The output signals of the preamplifier are applied to the final Y amplifier. The preamplifier and the final Y amplifier together form a shunt-series feedback circuit as previously described. The final Y amplifier consists of two differential amplifier stages using part of IC26 (8 and 11) and transistors TS34, TS36, TS37, TS38, balanced by TS39, TS41, TS42, TS43.

The first differential amplifier stage, IC26 (8 and 11) is stabilised by series feedback produced by the un-decoupled emitter resistances.

One input of this amplifier stage is driven by the Y signal applied to the base of IC26 (point 9) from the preamplifier; the other input, on the base of IC26 (point 6), is derived from the other half of the balanced preamplifier.

The second differential amplifier stage consists of two single-ended push-pull sections, TS34, TS36, TS37, TS38 and TS39, TS41, TS42, TS43, which constitutes the shunt feedback network of the final Y amplifier. Transistors TS34, TS36 and similarly, TS42, TS43, permit high voltage working and also provide fast switching to compensate for stray capacitance effects, thus giving improved rise-time on the leading edges of squarewave signals.

Resistors R82 and R98 in the output feed to the vertical deflection plates of the c.r.t. clamp any parasitic oscillations, due to capacitive effects, that may occur at certain frequencies. Although this has a limiting effect on the bandwidth, the bandwidth of the final Y amplifier is inherently better than required.

The gain of the final Y amplifier, as likewise that of the X final amplifier, is mainly determined by the ratio of shunt-feedback resistors to the series feedback resistors.

The theoretical value of the gain is found by the following approximation:

$$\text{Gain} = \frac{\text{shunt feedback resistance}}{\text{series feedback resistance}} = \frac{R83 + R87 + R93 + R94}{\text{emitter resistance of IC26 (8 and 11)}}$$

Capacitors C66 to C69 across the shunt feedback resistors provide high frequency compensation.

3.1.1.5 Trigger Pick-off

For internal triggering, a signal is taken from one side of the preamplifier stage via resistor R75 and applied to the base of transistor TS33. When the internal triggering mode is selected (pushbutton SK8 depressed) or none of the trigger pushbuttons is depressed, a + 12 V supply is coupled via R78 to the emitter of TS33. The resulting positive-going edge at the collector is coupled via C409 to the trigger amplifier.

3.1.2 Triggering

The trigger source switches for triggering the time-base generator, can select any of the following input sources:

- an internal signal from the vertical channel,
- an external signal from the front-panel socket via the X and trigger preamplifier,
- a signal derived from the mains supply (line triggering).

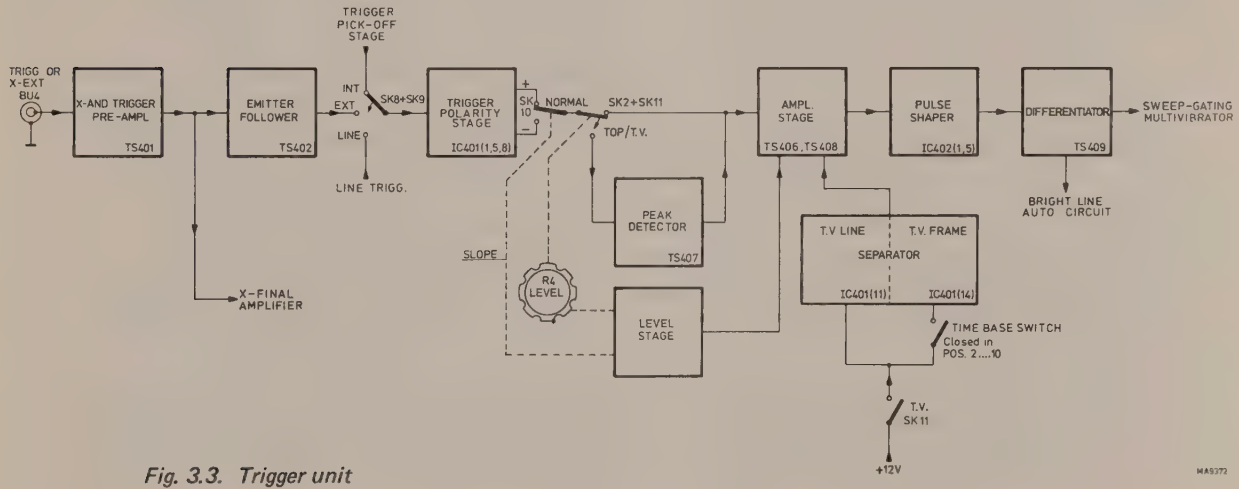


Fig. 3.3. Trigger unit

Source selection is by means of pushbutton switches SK8 (INT) and SK9 (EXT). Simultaneous selection of SK8 and SK9 (LINE) provides triggering from the mains supply.

If TV is selected (SK11 depressed), a peak detector and sync separator stage facilitate triggering from TV line and frame signals. The peak detector is also switched into circuit when SK2 is in the TOP position. Sources applied to the front-panel TRIG or X EXT socket (BU4) can be used for either triggering or X deflection purposes.

3.1.2.1 X and trigger preamplifier

External input sources applied to the TRIG or X-EXT front-panel socket (BU4) are coupled via a frequency compensated voltage divider (x10) R401, R404 to the base of emitter-follower TS401, which is protected against excessive positive signals by diode GR401. In the X-EXT mode (i.e. position 1 of SK4), the output signals of emitter-follower TS401 are fed via diode GR402 to the X-final amplifier. When external signals are used for triggering purposes, these signals are a.c.-coupled via C404 to the base of a second emitter-follower, TS402. The output from the emitter is fed to the trigger source selector switches SK8 and SK9.

3.1.2.2 *Trigger polarity stage*

Note: Transistors forming part of integrated circuits are referred to by their collector numbers.

The trigger polarity stage comprises a trigger slope amplifier, transistors IC401(5) and IC401(1), which feeds an emitter-follower, IC401(8).

The trigger slope amplifier consists of two shunt-feedback amplifiers, the gain of which is mainly determined by the values of resistors R427 and R436. The amplifying stage IC401(1) is used for phase inversion when the + ve slope is selected. The collector voltages of transistors IC401(5) and IC401(1) are equal in amplitude and opposite in phase. These collector voltages are diode-switched by means of the +12 V supply according to the position of the ± selection pushbutton (SK10). This selection switch enables triggering on either the positive-going or the negative-going edge of the triggering signal.

Depending on the position of the ± switch SK10, diodes GR408, GR409, or GR411, GR412 will conduct and the respective collector voltages will be applied to the base of emitter-follower IC401(8), see Fig 3.4. and Fig 3.5.

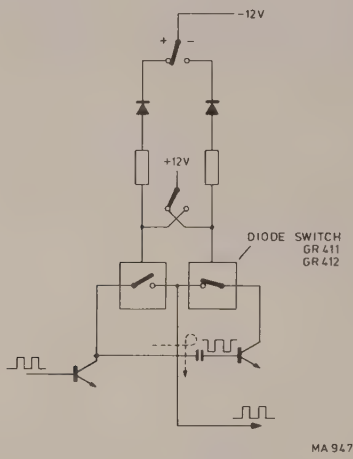


Fig. 3.4. Triggering on +ve-going EDGE

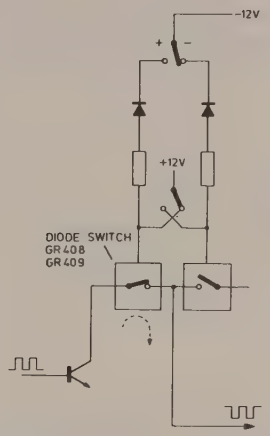


Fig. 3.5. Triggering on —ve-going EDGE

3.1.2.3 *Peak detector and amplifier stage*

The NORMAL mode permits two kinds of triggering:

a. NORMAL/LEVEL mode, which permits triggering at any point (level) on the chosen trigger input signal;
b. NORMAL/TOP mode, in which triggering occurs at approximately the top of the chosen trigger input signal.

In the NORMAL/LEVEL mode, the trigger signal output from emitter-follower IC401(8) is a.c.-coupled via C416 to the junction of R447, R448, where it is summed with the d.c. level from the wiper of R4 (LEVEL) via R441. Thus, for each setting of the LEVEL potentiometer, a different part of the trigger signal can be amplified by TS406.

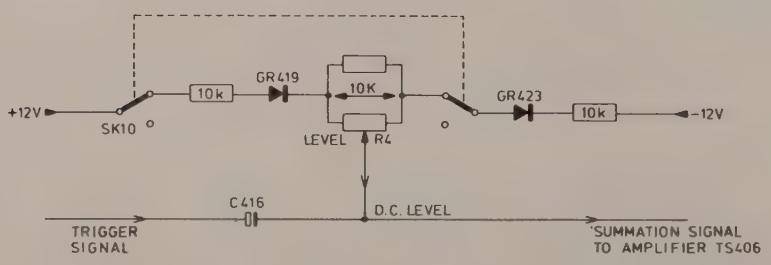


Fig. 3.6. Simplified diagram of the level circuit

As can be seen from the simplified diagram Fig. 3.6., the LEVEL control lies at the midpoint of a balanced potential divider network between + 12 V and −12 V. The wiper can swing nominally between +4 V and −4 V.

In the NORMAL/TOP mode, a +12 V supply via the TOP switch (SK2) is fed to the base of the switching transistor TS407, thus causing it to conduct. As a result, the peak detector (GR413, GR414, C416, C417 and R439) is activated, which clamps the base of transistor TS406 to conduct on signal peaks. In this mode, the emitter of TS406 is biased by voltage divider R456 and R457 between the −12 V supply and the 0 V rail via the switching diodes GR424 and GR426.

In the TV mode, the switching transistor TS407 conducts to provide peak-detection of the synchronising pulses of a video signal. To achieve this, a +12 V supply is fed via the TV/NORMAL switch (SK11) and diode GR427 to the base of switching transistor TS407. In this mode, the emitter of transistor TS406 is biased via the switching diodes GR417 and GR418 from a preset potentiometer R460, which provides the appropriate TV trigger adjustment.

The amplified signal at the collector of TS406 is matched to the pulse shaper circuit by means of emitter-follower TS408. The amplified level of the signal is such that it exceeds the hysteresis gap (see Fig. 3.7.) of the Schmitt trigger pulse shaper formed by IC402(5) and IC402(1). In this way, switchover of the Schmitt trigger occurs on both positive and negative-going excursions of the input trigger signal and the fast switching action results in square wave outputs.

3.1.2.4 Sync separator

When the TV mode is selected, triggering occurs on the line or frame sync pulses of a video signal, the appropriate trigger signals being coupled by means of the TIME/DIV switch. In the switch positions 200ms to 0.5 ms, frame triggering takes place, a +12 V supply being switched via SK11 to the bases of both IC401(11) and IC401(14). Sync separation occurs via the low-pass filter formed by R452 // R453 and C419 // C420 // C421.

In the positions 0.2ms to 0.5 μs of the TIME/DIV switch, only IC401(11) conducts and brings the low-pass filter R452 // R453 and C419 into circuit. The reduced capacitance enables line triggering to take place. The switching transistor IC401(11) is controlled via SK11 from the +12 V rail.

3.1.2.5 Trigger pulse shaper and differentiator

The trigger pulse shaper consists of transistors IC402(5) and IC402(1) in Schmitt trigger configuration. This pulse shaper circuit transforms the emitter output voltage of emitter-follower TS408 into a square-wave voltage of constant amplitude and width, having the same frequency as its input signal. Inset Fig. 3.7. shows how the output of the fast-acting Schmitt trigger circuit switches over when an input signal is applied. From this figure it is evident that the input signal should be of sufficient magnitude to exceed both limits of the hysteresis gap (switchover points) in order to obtain a square-wave output voltage.

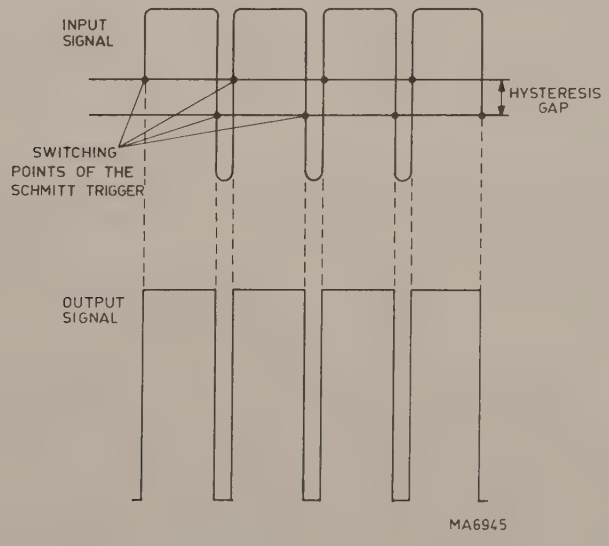


Fig. 3.7. Pulse shaper operation on receipt of trigger input signal

This square-wave is differentiated by capacitor C424 and the resistance of

$\frac{R494 \,//\, R497}{H_{FE}\ (TS409)}$ (i.e. the transform of base resistance to emitter resistance of TS409) into narrow positive and negative pulses. The negative-going spikes cause TS409 to conduct and initiate the sweep of the sawtooth generator. The positive-going spikes serve as control pulses for the BRIGHT-LINE-AUTO circuit.

3.1.3 Time-base generator

The time-base generator comprises a sweep-gating multivibrator, a sawtooth generator, a hold-off circuit, a bright-line auto circuit and an X-final amplifier.

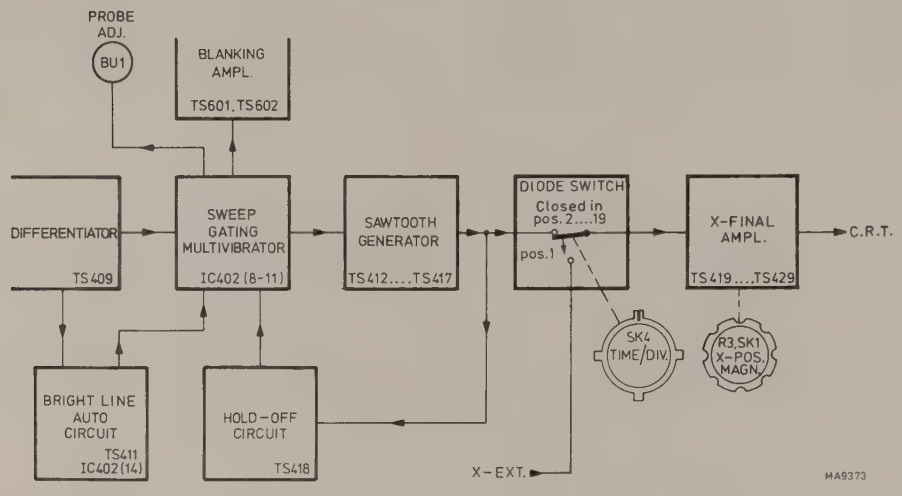


Fig. 3.8. Time-base generator

Before considering these stages in detail, the general principle is briefly described. Basically, the sweep-gating multivibrator, under the control of trigger pulses from the differentiator and also feedback pulses from the hold-off circuit, supplies square-wave pulses to the switching transistor (TS413) of the sawtooth generator. The time-base capacitors (effectively in parallel with the switching transistor) are charged linearly through a constant-current source to provide the forward sweep, and are discharged rapidly by the switching transistor to provide the flyback period. The resulting sawtooth output is taken from two transistors in Darlington pair configuration and fed to the X-final amplifier.

3.1.3.1 Sweep-gating multivibrator and sawtooth generator

The sweep-gating multivibrator comprises transistors IC402(8) and IC402(11) connected in Schmitt trigger configuration. In the state when transistor IC402(8) is cut off and transistor IC402(11) is conducting, switching transistor TS413 is cut off. While TS413 remains cut off, current source transistor TS412 charges capacitor C431 or, depending on the position of the TIME/DIV switch (SK4), capacitors C431 and C429 with a constant current. This results in a linearly increasing voltage across these capacitors, which constitutes the forward sweep. When switching transistor TS413 conducts, the timebase capacitors discharge rapidly (i.e. the flyback period). The sawtooth voltage thus produced is taken off by a cascade Darlington pair circuit consisting of emitter-followers TS414, TS416 and applied to both the horizontal final amplifier, and via feedback components (GR446, GR447, R493) and hold-off circuit (TS418) to the sweep-gating multivibrator. The timebase output sawtooth and the feedback sawtooth waveforms are shown in graphs 12 and 11 respectively on the overall circuit diagram, Fig. 3.34.

The input voltage of the sweep-gating multivibrator is controlled by:
- a d.c. voltage derived from the stability potentiometer R522
- trigger pulses derived from the pulse shaper
- a bias voltage supplied by the auto circuit
- the sweep feedback voltage via the hold-off circuit.

When this input voltage reaches a pre-determined level, the sweep-gating multivibrator switches over. In this condition, transistor IC402(8) is conducting and transistor IC402(11) is cut off. Switching transistor TS413 then starts to conduct and the timebase capacitance is discharged via this transistor. On arrival of the next trigger pulse this cycle is repeated.

The magnitude of the charging current of the timebase capacitors, and thus the time coefficient, is determined by resistors R581 to R591. Preset potentiometers R506 and R508 permit adjustment of the time coefficients in the ranges 200 ms/div to 0.5 ms/div, and the range 0.2 ms/div to 0.5 μs/div respectively, by controlling the base current of transistor TS412.

Timebase capacitor C429 is switched into the circuit by means of transistor TS417, which is switched by a positive voltage applied to its base in certain positions of the TIME/DIV switch.

Blanking pulses are provided by the collector circuit of IC402(11) via R601 and C610 for the beam blanking stage. In addition, a rectified output is provided via GR432 for the front-panel PROBE ADJUST socket (BU1). (Graphs ▽10▽ and ▽9▽ respectively, Fig. 3.34.

3.1.3.2 Hold-off circuit

The hold-off circuit consists of transistor TS418, capacitors C434, C436 and diode GR447; the circuit establishes a time interval at the end of the sweep to inhibit the sweep-gating multivibrator for a period. Due to the blocking effect of diode GR447, the charged hold-off capacitance C436 (and C434 if switched) is unable to follow the decay of the sawtooth voltage. The capacitor voltage therefore decays at an RC time that is sufficiently large to permit total discharge of the timebase capacitors and to enable all circuits to return to their quiescent states before the next sweep is produced. During this RC time, the input level of the sweep-gating multivibrator is so high that incoming trigger pulses are ineffective. The hold-off capacitance is charged by the TIME/DIV switch for the various sweep rates to allow the correct hold-off time. Capacitor C436 is permanently in circuit, while C434 is switched in circuit by means of transistor TS418 in the 200 ms/div to 0.5 ms/div positions of the TIME/DIV switch.

3.1.3.3 Bright-line auto circuit

Basically, the bright-line auto circuit comprises electrolytic capacitor C437 effectively in parallel with the complementary transistors TS411 and IC402(14). The complementary pair can be considered as a thyristor. Positive-going trigger pulses at the base of IC402, pin 12, cause it to start conducting. In turn, TS411 starts to conduct and capacitor C437 discharges via resistor R499. Diode GR429 is therefore blocked as its anode goes negative and the hysteresis levels of the sweep-gating multivibrator are such that it is driven by the negative-going trigger pulses received via TS409.

However, when no trigger pulses are available, the complementary transistors are non-conducting and capacitor C437 charges towards the + 12 V rail via R498, R499. Hence, diode GR429 conducts and the sweep-gating multivibrator hysteresis levels are set so that the initiation of the sweep is dependent only on the sweep feedback voltage. The timebase generator is therefore free-running and a bright horizontal line will be displayed.

When triggered at frequencies above about 10 Hz, the average output voltage of the auto circuit is low, therefore diode GR429 is cut off. Consequently, the sweep-gating multivibrator hysteresis levels are returned to the normal triggered condition.

3.1.3.4 X-Final amplifier

The output of the timebase sawtooth generator, or the output of the TRIG OR X-EXT preamplifier are selected by a diode-switching network to provide an input for the X-final amplifier.

The diode-switching network is controlled by the position of the TIME/DIV switch and comprises the diodes GR441 to GR444.

In the X-EXT position of the TIME/DIV switch, the +12 V supply permits diodes GR443 and GR444 to conduct, thus passing the signal employed for external X deflection to the base of transistor TS419. In the other positions of the TIME/DIV switch, the +12 V supply via diodes GR438 or GR439 permits diodes GR441 and GR442 to conduct, thus passing the timebase sawtooth signal to the base of transistor TS419.

The X-final amplifier consists of two differential amplifier stages. The first stage, transistors TS419 and TS422, is stabilised by series-feedback. One input of this amplifier is driven by the signal passed by the diode-switching network; the other input is driven by a d.c. voltage derived from the X-POSITION potentiometer, which allows horizontal shift of the trace. Transistor TS421 in the emitter circuit of transistors TS419 and TS422 provides a constant-current source.

The second differential amplifier consists of two single-ended push-pull sections, TS424, TS426 and TS427, TS428, with shunt feedback, and is supplied with constant current from current source TS423, TS429. This final stage is supplied from the + 200 V rail because the X plates of the c.r.t. are mechanically displaced such that they are less sensitive than the Y plates. The fast switching currents of this output circuit allow faster charge and discharge of stray capacitances, thus enlarging the bandwidth of the X-amplifier. The deflection signal is fed to the X plates of the c.r.t. via resistors R561 and R562.

The gain of the X-final amplifier is mainly determined by the ratio of the shunt-feedback resistors R549 and R556 and the common emitter resistor (i.e. the series feedback) of transistors TS419 and TS422.

The theoretical value of the gain can be found by the following approximation formula:

$$\text{Gain} = \frac{\text{shunt feedback resistance}}{\text{series feedback resistance}} = \frac{R549 + R556}{R534 + R536 + \text{mutual conductance}}$$

The practical gain value obtained is slightly lower than the theoretical gain.

When the front-panel X-MAGN switch is operative for 5 times magnification, the series-feedback resistance is shunted by resistor R533 thus reducing its value by a factor of five. Consequently, the gain of the stage is correspondingly increased by the same factor. Capacitors C445 and C449 across the feedback resistors R556 and R549 respectively provide high frequency compensation.

3.1.4 Cathode-ray tube circuit

The cathode-ray tube circuit comprises the high-voltage and low-voltage power supply, the c.r.t. itself and the brightness, focus and astigmatism controls, and the beam-blanking amplifier. A block diagram of the c.r.t. is given in Fig. 3.9.

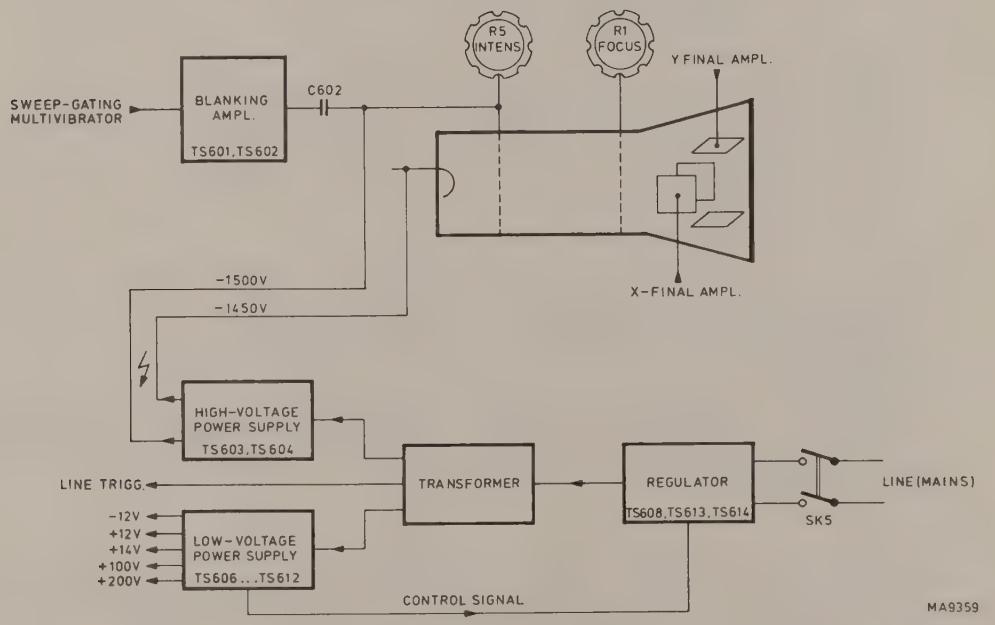


Fig. 3.9. Cathode-ray tube circuit

3.1.4.1 C.R.T. controls

By means of the INTENS potentiometer R5, the brightness of the display can be continuously controlled. The display can be focused by means of the FOCUS potentiometer R1. Both of these front panel controls are shown in the c.r.t. circuit, Fig. 3.9.

The average output voltage of the Y-final amplifier is applied to the "astigmatism" control grid (pin 9) via resistors R605 and R620. This obviates the necessity for astigmatism correction or adjustment by a manual control.

Both the FOCUS and INTENS controls form part of a potential divider network across the 1.5 kV output that is derived from a voltage multiplier in the high-voltage power supply. The slider of the INTENS control provides the cathode potential for the c.r.t. that regulates the beam current. The slider of R1, the FOCUS control, is connected direct to the focus grid (pin 8).

3.1.4.2 Blanking amplifier

The blanking amplifier blanks the c.r.t. during the fly-back period of the timebase and unblanks the c.r.t. during the sweep period; if the TIME/DIV switch occupies the X-EXT position the c.r.t. is continuously unblanked. During the timebase flyback period, the Wehnelt cylinder (pin 3) must receive a negative-going pulse for blanking. This pulse is derived from the sweep-gating multivibrator and is amplified by a single-ended push-pull amplifier consisting of transistors TS601 and TS602. The blanking signal is fed to the Wehnelt cylinder via resistor R608 and capacitor C602, after which d.c. restoration takes place in conjunction with diode GR608. Diode GR601 clips the output signal during the unblanking period. If the top of the unblanking pulse is not flat, uneven illumination of the trace will result.

3.1.4.3 Input regulator and low-voltage power supplies

The low-voltage power supply circuit basically consists of a voltage-regulated input circuit under the control of a light-emitting diode in the rectified +14 V circuit, a mains transformer and the low-voltage rectified supplies for the oscilloscope circuits (see Fig. 3.10).

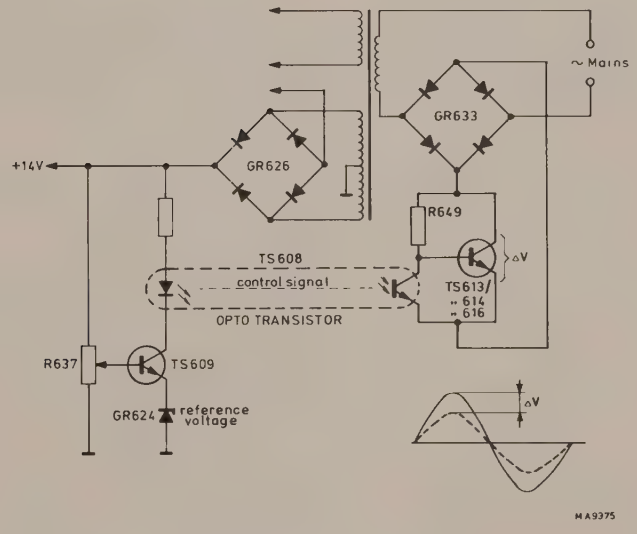


Fig. 3.10 Low-voltage power supply with regulator

The incoming mains voltage is fed via the power ON/OFF switch (SK5), the thermal fuse (VL601), the voltage selector (SK12) and the regulating network to the appropriate primary tappings on the mains transformer (T601).

The input regulator network comprises bridge rectifier GR633, series regulator transistors TS613, TS614, TS616 and an opto-transistor TS608. In principle, te power supply regulator operates as follows. As shown in the functional block diagram, Fig. 3.10., after transforming and rectifying, the +14 V supply is applied to the preset potentiometer R637, the slider voltage of which is compared with the reference voltage of zener diode GR624 by transistor TS609.

Assuming that the slider voltage, and thus the base voltage of TS609 tends to rise, this results in a collector current increase of this transistor with a corresponding increase in the light emission in the l.e.d. part of the opto-transistor. Since the output signal of an opto-transistor is proportional to its input signal, its collector current is also increased. As a result, less base current is applied to transistor TS614 of the Darlington pair (TS614, TS616); consequently its collector-emitter voltage rises (i.e. △ V in Fig. 3.10.). As the mains transformer primary voltage is in series with the collector-emitter voltages of transistors TS613 and TS614, the

voltage across the mains transformer drops. This voltage drop counteracts any tendency for the secondary voltage to rise, and maintains a state of equilibrium. Zener diodes GR639 and GR641 provide a measure of protection for the regulating network against excessive input voltages.

The mains transformer has four secondary windings:
- a heater winding for the c.r.t.
- a winding for the high-voltage power supply
- a winding for the +200 V/+100 V supply
- a winding for the ±12 V/± 14 V supply.

The ± 12 V / ± 14 V d.c. supply is derived from a full-wave bridge rectifier GR626 and smoothed by electrolytics C618 and C622. The + 12 V stabilised supply is derived from the + 14 V supply via the series transistor TS606. The base of TS607 is controlled by a potential divider R628, R636 across the + 14 V supply. Any tendency for the potential to change is amplified by TS607 and the resulting collector current controls the base of the series transistor TS606 accordingly. The series transistor can be compared to a variable resistor that can be changed to control the output current.

Similarly, the stabilised −12 V supply is derived from the −14 V supply via series stabilising transistor TS612.

If the supply current of any of the power supplies becomes excessive, for example, due to a short-circuit, the reference voltage of zener diode GR624 will drop, resulting in more light emission from the l.e.d. and thus a reduction of the transformer primary voltage.

The type and properties of the X and Y final amplifiers obviate the need for stabilised supplies for the +100 V and +200 V rails. For these voltages the primary-regulation is sufficient.

3.1.4.4 High-voltage power supply

The high-voltage power supply consists of a quadruple voltage multiplier, a voltage divider that produces cathode, control grid and focus potentials for the c.r.t., and a compensation circuit (TS603, TS604) to compensate h.t. voltage ripple and variations (see Fig. 3.11.).

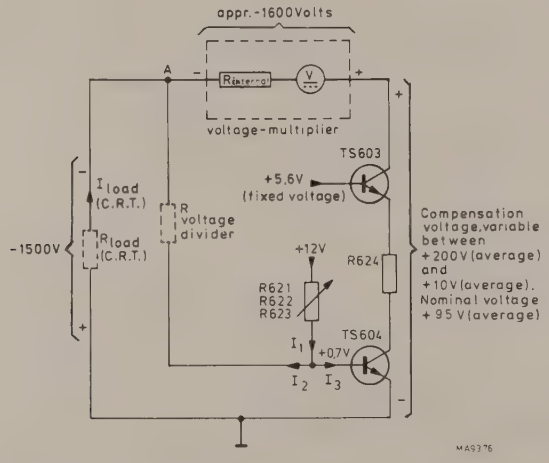


Fig. 3.11. High-voltage power supply

The −1500 V is derived by applying the secondary mains transformer voltage to a diode voltage-quadrupler network where it is multiplied by four. The compensation circuit operates as follows.

Assume that the −1500 V output of the voltage multiplier network (point A in Fig. 3.11.) tends to rise (i.e. go more −ve) with a decrease in ripple or load through the c.r.t.

Since I_1 is constant because of the stabilised +12 V and the fixed base-emitter voltage of +0.7 V, and I_2 will increase (because of the voltage increase across the voltage divider), then I_3 will drop. This means that less base current is applied to transistor TS604 causing a decrease in current through-transistors TS603 and TS604. Their collector-emitter voltages will therefore rise, this rise thus compensating for the negative-going rise of the −1500 V supply. In other words, the algebraic sum of the potential across the voltage multiplier and the potential across the compensation network is equal to −1500 V.

Preset potentiometer R614 (part of voltage divider R) controls the c.r.t. current. Adjustment of the −1500 V is obtained by controlling the base current of TS604 by preset potentiometer R621.

3.2 CHECKING AND ADJUSTING

3.2.1 General information

The following information provides the complete checking and adjusting procedure for the PM3225 oscilloscope. As some of the circuits are interdependent, the given order of checking is advised. The procedures are, therefore, presented in a sequence that is best suited to this order and, for convenience, the adjusting elements and their functions are tabulated in the Condensed Adjusting Procedure (page 81). Prior to checking and adjusting a particular circuit, care must be taken to ensure the accuracy of all associated circuits.

Only skilled personnel aware of the hazards involved should perform those adjustments which necessitate the removal of covers from an oscilloscope that is connected to the mains supply. In all other circumstances, covers should remain fitted as long as the instrument is live (see also chapter 2, "DIRECTIONS FOR USE").

The tolerances stated in the checking and adjusting procedures apply only to instruments which are completely set up, and may differ from the data given in the specification chapter i.e. 1.2 TECHNICAL DATA.

3.2.2 Test equipment and tools required

For a complete checking and adjusting procedure, you will need the tools and test equipment listed in the following table.

TEST EQUIPMENT

Description of the test instrument	*Specification of the test instrument*	*Suitable test instrument*	*Usage*
Digital multimeter.	AC/DC instrument, accuracy within 0.1%.	Philips PM2421 or equivalent.	C.R.T. circuit. Trouble shooting.
Time-mark generator.	Providing markers of 1 ms to 0.5 μs, accuracy within 0.5%.	–	Time-base timing checks.
T.V. pattern generator or T.V. source.	Providing frame and line sync pulse output. Ampl. at least 100 mV.	Philips PM5504 or equivalent.	Time-base, T.V. triggering.
Squarewave generator or amplitude calibrator.	Providing output voltages variable from 10 mV to 30 V (accuracy within 0.5 %), frequency range 1 KHz ... 100 kHz rise time <5ns.	–	Attenuator response, vertical gain and response checks.
Sinewave generator.	Providing output voltages variable from 10 mV to,10 V frequency range 1 kHz ... 15 MHz.	Philips PM5145 suitable for most purposes.	Vertical amplifier bandwidth and triggering checks. Trouble shooting.
Monitor oscilloscope.	0 ... 15 MHz bandwidth	Philips PM3225 or equivalent.	Trouble shooting.
Amp.-meter.	Moving-iron meter.	–	Mains current consumption.
Variable mains transformer.	Well insulated for safe checking.	Philips 2422 529 00005.	Trouble shooting.
Probe 10x attenuaton.	Suitable for input capacies of 20 to 30 pF.	Philips PM9336 or equivalent.	Trouble shooting.
2:1 Dummy probe.	1 MΩ// trimmer 3-60 pF.	See Fig. 3.12	Attenuator reponse.
Trimming tool kit.	Low capacitance trimming tool.	Philips. See Fig. 3.26	Adjusting and maintenance.

3.2.3 Starting positions of the controls

All preset potentiometers and trimming capacitors are indicated on either the vertical or the horizontal printed-wiring boards (see Fig. 3.13, 3.32, 3.33), in addition they have been listed in the heading of the various sections.

All controls mentioned without item numbers in the 'checking and adjusting' procedure are located on the front panel. Unless otherwise stated, the front-panel controls must be set to the following positions:

- Trigger switches of the time-base to positions: INT, +, and NORMAL
- AMPL/DIV switch to 50 mV
- TIME/DIV switch to .2 ms
- AC/DC switch to AC
- 0 switch to 0
- FOCUS control to mid-position
- Y POSITION control to mid-position
- X POSITION control to mid-position
- X MAGN switch depressed (x1)
- LEVEL switch fully clockwise (TOP)
- INTENS control to normal intensity
- POWER switch to ON

Note: In general, a warm-up period of at least 15 minutes is recommended.

3.2.4 Mains current

- Check that the mains voltage adapter (SK12) has been set to 220 V and connect the instrument to such a voltage, frequency 46 to 400 Hz.
- Switch the oscilloscope on and check that the pilot lamp lights up
- Check that the current consumption does not exceed 75 mA (measured with a moving-iron meter)

3.2.5 Cathode-ray tube circuit

The trimming potentiometers for adjusting the +12 V (−12 V) and the intensity are located on the vertical printed-wiring board that lies vertically in the middle of the instrument, adjacent to the c.r.t.

With the front-panel controls set as stated under section 3.2.3., make the following adjustments.

3.2.5.1 +12 V supply (R637)

- Check that the voltage between the collector of TS606 (i.e. point A, Fig. 3.13) and the 0 V rail is +12 V, + or − 30 mV; if necessary, readjust potentiometer R637.
- Vary the a.c. voltage to which the instrument is connected between 198 V and 242 V
- Check that the +12 V do not vary more than 40 mV.

3.2.5.2 INTENS or −1500 V (R621)

- Rotate the INTENS control 90° clockwise from the OFF position,
- Set the LEVEL control to the LEVEL position.
- Connect a d.c. measuring instrument between the collector of TS603 and the O V rail; if necessary, adjust resistor R621 to indicate 90 V (+5%).

3.2.5.3 INTENS minimum (R614)

- With the INTENS control at 90° clockwise from the OFF position, and the LEVEL control to the LEVEL position, adjust potentiometer R614 until the trace displayed on the c.r.t. just disappears.

3.2.6 Time-base generator

The trimming potentiometers for adjusting the stability, time coefficients and the TV trigger of the time-base generator are located on the horizontal printed-wiring board that lies horizontally at the base of the instrument.

With the front-panel controls set as stated under section 3.2.3., make the following adjustments.

3.2.6.1 Stability (R522)

- Adjust FOCUS and INTENS controls for a normal display (i.e. approx. at their mid-stroke position)
- Switch the LEVEL control to TOP position
- Set the wiper of potentiometer R522,20° (+ or − 5°) from the point where triggering commences.

3.2.6.2 Time coefficients 200 ms ... 0.5 ms (R506)

- Set TIME/DIV switch to .5 ms
- Release 0 pushbutton
- Apply a time marker voltage of 200 mV with a repetition time of .5 ms to Y_A input socket
- Check that the 8 centre periods have a total width of 8 div ± 2 sub-divisions; if necessary, readjust potentiometer R506
- Set the X POSITION control as necessary

3.2.6.3 Time coefficients 0.2 ms ... 0.5 µs (R508)

- Set TIME/DIV switch to .5 µs
- Release 0 pushbutton
- Change the repetition time of the input signal to 0.5 µs
- Check that the 8 centre periods have a total width of 8 div ± 2 sub-divisions; if necessary, readjust potentiometer R508
- Set the X POSITION control as necessary

3.2.6.4 TV trigger adjustment (R460)

- Set AMPL/DIV switch to 0.1V.
- Set TIME/DIV switch to 5 ms.
- Set TV/NORMAL switch to TV
- Depress +/– switch to –
- Release 0 pushbutton
- Apply a television signal of 240 mV, positive video (French system) to Y_A input socket.
- Check that the display starts with a frame sync pulse; if necessary, readjust potentiometer R460
- Set TIME/DIV switch to 20 µs
- Check that the display starts with a line sync pulse

3.2.7 Vertical amplifier

The trimming potentiometers and capacitors for trace position adjustment, sensitivity and square-wave response are all located on the vertical printed-wiring board that lies vertically in the middle of the instrument, adjacent to the c.r.t.

With the front panel controls set as stated under section 3.2.3., make the following adjustments:

Note: Prior to adjusting the vertical amplifier, ensure that the cathode-ray tube circuit and the time-base generator are operating correctly, i.e. that they meet their specifications.

When one or more transistors or other components have been replaced in the vertical amplifier, it is advisable that the following adjustments are checked.

3.2.7.1 Range adjustment of Y POSITION Control (R46)

- Set 0 switch to 0
- Set AMPL/DIV switch to .1V
- Set TIME/DIV switch to 5 ms
- Set Y POSITION potentiometer to mid-range; if necessary, adjust R46 for display of trace on the centre graticule line. The range of the Y POSITION potentiometer is so adjusted for equal swing either side of the centre horizontal line.

3.2.7.2 SENSITIVITY (R74)

- Set AMPL/DIV switch to 2 mV
- Set TIME/DIV switch to 50 µs.
- Release 0 pushbutton
- Apply a voltage of exactly 12 mV p-p, 10 kHz, to Y_A input socket
- Check that the vertical display height is exactly 6 divisions; if necessary, readjust potentiometer R74
- Adjust the Y POSITION control as necessary

3.2.7.3 Attenuator response (C28, C31, C33, C36, C37, C38, C42, C43, C47, C48, C53)

- Set AMPL/DIV switch to 2 mV.
- Set TIME/DIV switch to 50 μs
- Release the 0 pushbutton.
- To equalize the input capacitance in all positions of the AMPL/DIV (i.e. attenuator) switch, for some adjustments, a 2:1 dummy measuring probe is connected in series with Y_A input socket. The dummy probe consists of the parallel circuit of a 1 MΩ resistor and a 3-60 pF trimmer (Fig. 3.12) and is adjusted as indicated in the following table.
- Connect a square-wave voltage with an amplitude as indicated in the following table, a repetition rate of 10 kHz and a rise time not exceeding 100 ns to Y_A input socket.
- Check that neither overshoot nor rounding is visible (maximum pulse top errors 2%) and also check the trace height; if necessary, correct the pulse top errors with the aid of the trimmers (Fig. 3.13) mentioned in the following table.

Position of the AMPL/DIV switch	*Signal to Y_A socket or Signal to 2:1 dummy*	*Adjusting element*	*Square-wave with a trace height*
2 mV/div	12 mV	C53	6 div + or −2%
2 mV/div	24 mV	trimmer in dummy	6 div + or −2%
5 mV/div	30 mV	C31	6 div + or −2%
5 mV/div	60 mV via dummy	C28	6 div + or −2%
10 mV/div	60 mV	C36	6 div + or −2%
10 mV/div	120 mV via dummy	C33	6 div + or −2%
20 mV/div	120 mV	C37	6 div + or −2%
50 mV/div	300 mV	C38	6 div + or −2%
.2 V/div	1.2 V	C42	6 div + or −2%
.5 V/div	3 V	C43	6 div + or −2%
2 V/div	12 V	C47	6 div + or −2%
5 V/div	30 V	C48	6 div + or −2%

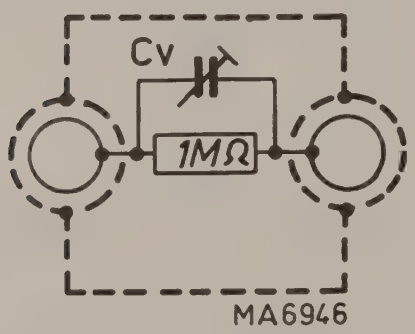


Fig. 3.12. 2:1 Dummy probe

3.2.7.4 H.F. Response (R63)

- Set AMPL/DIV switch to 2 mV
- Set TIME/DIV switch to .5 μs.
- Pull X-MAGN switch to x5
- Apply a square-wave signal of 12 mV, 100 kHz rise time $<$ 5 ns, at the Y input socket and adjust, if necessary, trimmer C63 on the vertical amplifier printed wiring board for a flat-top response with minimum overshoot (0.5 sub-div is acceptable).

3.2.7.5 Bandwidth of the vertical amplifier

- Depress X-MAGN switch to x1
- Set TIME/DIV switch to 5 μs
- Set AMPL switch to 2 mV / div
- Check the bandwidth at a trace height of 6 div in accordance with the following table:

Input sine wave on YA socket	*Frequency*	*Requiried trace height*
12 mV p-p	100 kHz	6 div
12 mV p-p	15 MHz	at least 4,2 div

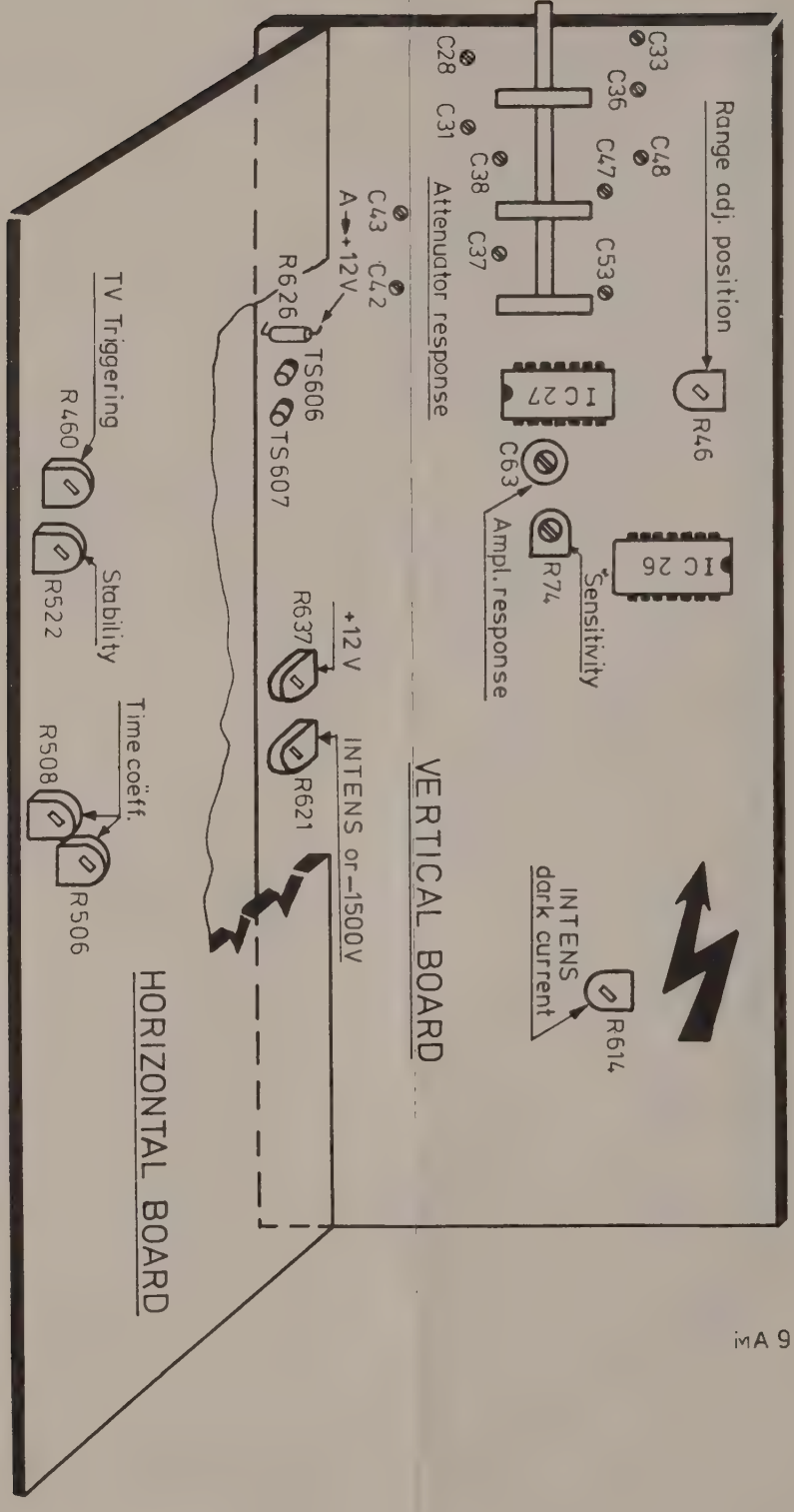


Fig. 3.13 Printed-wiring boards with adjusting references.

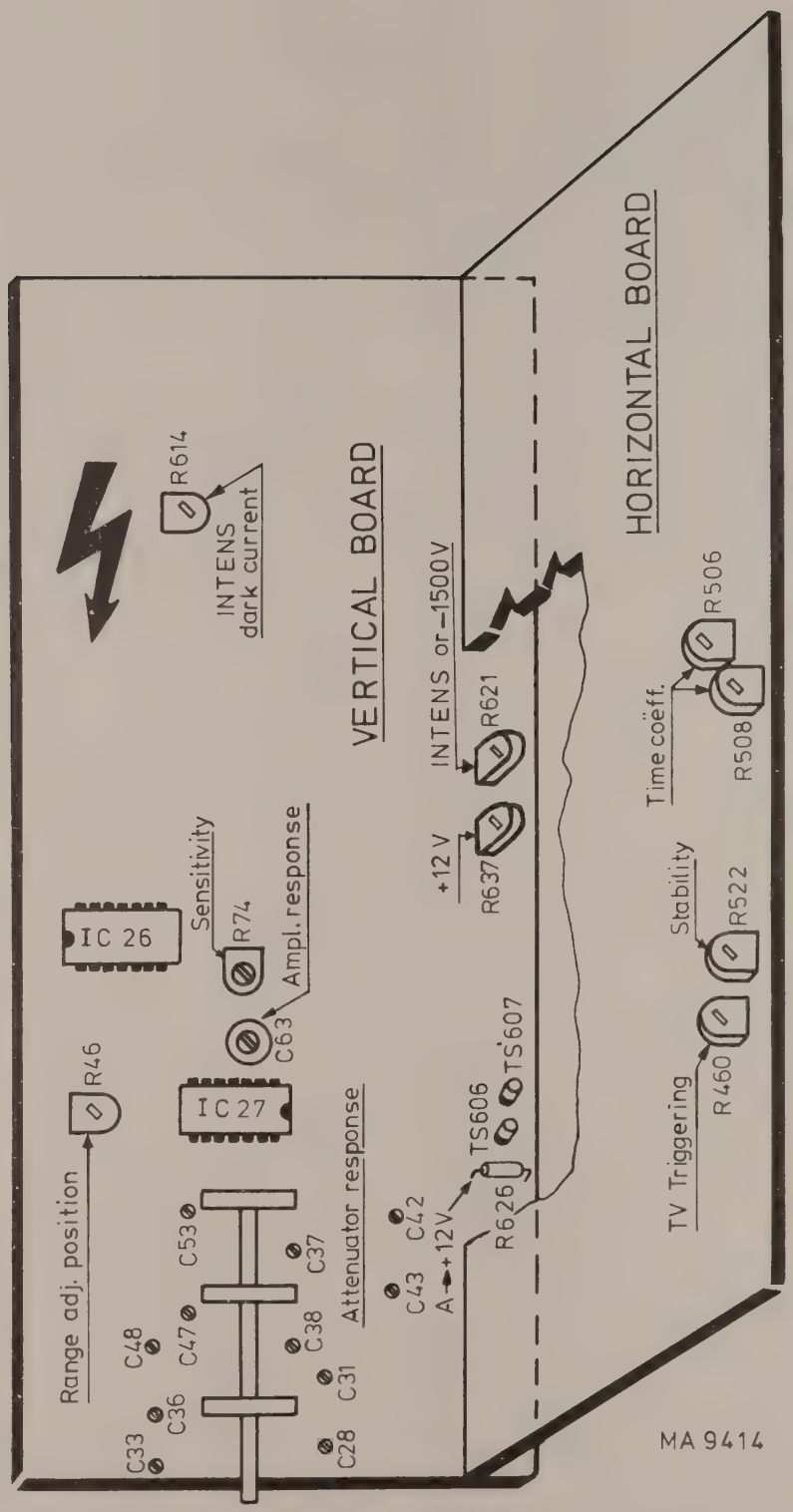


Fig. 3.13 Printed-wiring boards with adjusting references.

3.3 CONDENSED CHECKING AND ADJUSTING PROCEDURE

ADJUSTING ELEMENTS AND THEIR FUNCTIONS		SETTINGS OF CONTROLS OF THE INSTRUMENT					
		V/div.	T/div.	AC/DC	0	INT. EXT.	+
Adjustment and Adjusting sequence	Adjusting element	50 mV	.2 ms	AC	0	Intern	
CATH-RAY TUBE CIRCUIT + 12 V, − 12 V supply voltages	Potmeter R637	"	"	"	"	"	
Intens (−1500 volt)	Potmeter R621	"	"	"	"	"	
Intens (dark current)	Potmeter R614	"	"	"	"	"	
TIME-BASE GENERATOR Stability	Potmeter R522	"	"	"	"	"	
Time coëff. 200 ms − 0,5 ms	Potmeter R506	"	.5ms	"	0 released	"	
Time coëff. 0,2 ms − 0,5 μs	Potmeter R508	"	.5μs	"	"	"	
T.V. trigger adjustment	Potmeter R460	.1 V	5ms	"	"	"	
VERTICAL AMPLIFIER Range adjustment of POSITION	Potmeter R46	"	"	"	0	"	
Sensitivity (overall-gain)	Potmeter R74	2mV	50μs	"	0 released	"	
Square-wave response att.	Capac. C53	"	"	"	"	"	
" "	Use a dummy	"	"	"	"	"	
" "	Capac. C31	5mV	"	"	"	"	
" "	Capac. C28-Use dummy	5mV	"	"	"	"	
" "	Capac. C36	10mV	"	"	"	"	
" "	Capac. C33-Use dummy	10mV	"	"	"	"	
" "	Capac. C37	20mV	"	"	"	"	
" "	Capac. C38	50mV	"	"	"	"	
" "	Capac. C42	.2V	"	"	"	"	
" "	Capac. C43	.5V	"	"	"	"	
" "	Capac. C47	2V	"	"	"	"	
" "	Capac. C48	5V	"	"	"	"	
Square-wave response, amplifier	Capac. C63	2mV	.5μs	"	"	"	

NDER TEST

	TV NORM	Focus	Y-POS.	X-POS. MAGN.	Level TOP	Power-ON INTENS.	MEASURING
	NORM			x1	TOP	Normal INTENS.	Explanation + values
	"	"	"	"	"	"	Adjust at +12 V (+ or –30 mV) collect. TS606
	"	"	"	"	Level	90° OFF	Adjust d.c. voltage collect. TS603 at 90 V (+5%)
	"	"	"	"	"	"	Adjust with R614 at just **no** display
	"	Norm FOCUS	"	"	TOP	Norm. INTENS.	Set wiper R522, +20° clockwise from point of just no triggering
	"	"	"	Adjust	"	"	8 periods = 8 div. (± .2 s.d) {Measured across the centre 8 div.
	"	"	"	Adjust	"	"	8 periods = 8 div. (± .2 s.d) {Measured across the centre 8 div.
	TV	"	"	"	"	"	Adjust at frame pulses (apply a positive video signal)
	NORM	"	"	"	"	"	Set POSITION potmeter at mid-range adjust with R46 for display at centre graticule line
	NORM	"		"	"	"	Apply 12 mV, Frequency 10 kHz } adjust for H = 6 div.
	"	"	"	"	"	"	Apply 12 mV, adjust for square-wave response
	"	"	"	"	"	"	Apply 24 mV, adjust dummy for square-wave response
	"	"	"	"	"	"	Apply 30 mV, adjust for square-wave response
	"	"	"	"	"	"	Apply 60 mV, adjust for square-wave response
	"	"	"	"	"	"	Apply 60 mV, adjust for square-wave response
	"	"	"	"	"	"	Apply 120 mV, adjust for square-wave response
	"	"	"	"	"	"	Apply 120 mV, adjust for square-wave response
	"	"	"	"	"	"	Apply 300 mV, adjust for square-wave response
	"	"	"	"	"	"	Apply 1,2 V, adjust for square-wave response
	"	"	"	"	"	"	Apply 3 V, adjust for square-wave response
	"	"	"	"	"	"	Apply 12 V, adjust for square-wave response
	"	"	"	"	"	"	Apply 30 V, adjust for square-wave response
	"	"	"	x5	"	"	Apply square-wave voltage 12 mV, 100 kHz adjust for flat top and min. overshoot

3.4. INFORMATION FOR ASSISTANCE IN FAULT-FINDING

3.4.1. Mains transformer data

The available unloaded voltage tappings and the number of turns per winding are listed in the circuit diagram (Fig. 3.34), in the form of a table.

3.4.2. Voltages and waveforms in the instrument

The d.c. voltage levels at the electrodes of the transistors and the voltage waveforms in the time-base generator and Y-amplifier are shown at the relevant points on the circuit diagram (Fig. 3.34).
The waveforms have been measured under the following conditions:

- Input signal on Y input socket: 5 V_{p-p} sine-wave voltage, frequency 1 kHz,
- Level potentiometer in TOP position.
- Trigger switches at INTERN, +, and NORMAL.
- Y-POSITION and X-POSITION controls at mid-range.
- AMPL/DIV switch to 1 Volt.
- TIME/DIV switch to .5 ms.

The voltage values are typical and may slightly differ per instrument.

3.4.3. Remark

In case of a defect, it is always possible to apply to the world wide PHILIPS Service Organization.
When the instrument is to be sent to a PHILIPS Service Workshop for repair, the following points should be observed:

- Attach a label with your name and address to the instrument.
- Give a complete description of the faults found, or the service required.
- Use the original packing, or, if this is no longer available, carefully pack the instrument in a wooden crate or box.
- Send the instrument to the address obtained after consultation with the local PHILIPS Organization.

3.5 INFORMATION CONCERNING ACCESSORIES

3.5.1 Attenuator probe sets PM 9326 and PM 9327 (Fig. 3.14.)

These passive probe sets are equal but for the length of the probe cable, which is 1,15 m for the PM 9326 and 2 m for the PM 9327.

The sets consist of:

1 probe cable	Fig. 3.14. item 1
1 earth lead 15 cm	Fig. 3.14. item 2
1 earth lead 30 cm	Fig. 3.14. item 3
1 measuring probe 1:1 (black)	Fig. 3.14. item 4
1 test pin	Fig. 3.14. item 5
1 test hook	Fig. 3.14. item 6
1 attenuator probe 1:10 (grey)	Fig. 3.14. item 7
1 test clip	Fig. 3.14. item 8
1 box	Fig. 3.14. item 9

The measuring probe and the earth lead can be simply pulled from the cable. The test clip, test pin and test hook are screwed on to the measuring probe.

For ordering numbers of these parts, see list 3.6.4.1.

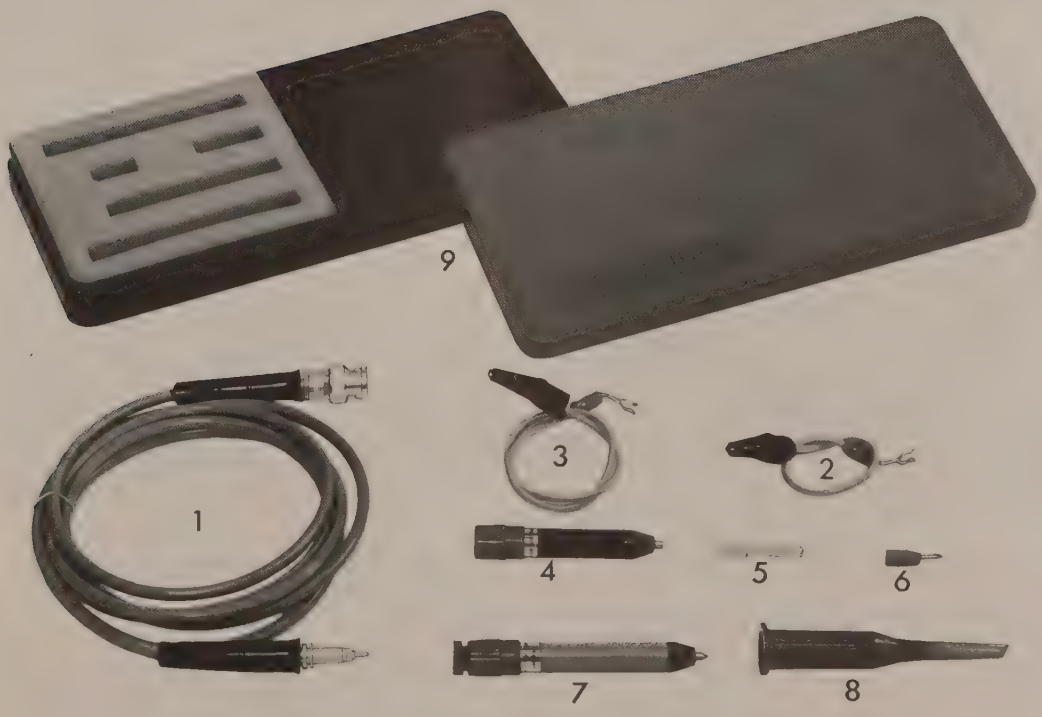


Fig. 3.14. Attenuator probe set PM 9326 (PM 9327)

3.5.1.1 Technical data

Attenuation	1:10 ± 3%
Input impedance	10 MOhm//10 pF
Max. permissible input voltage	1000 V_{p-p}

Maximum d.c. component 500 V with the blocking capacitor included into the circuit.

3.5.1.2 Adjustment (Fig. 3.15)

- Unscrew the probe locking nut by turning it anti-clockwise.
- Connect the measuring pin to socket PROBE ADJ of the oscilloscope
- Rotate the probe body to change the capacitance while watching the display for the desired waveform.
- When compensation is completed, carefully turn the locking nut clockwise, to lock it without disturbing the adjustment.

The attenuator probe causes distortion if it has not been properly adjusted.

See the following examples:

Note: For settings of the instrument controls, see Section 2.2.3:

Adjustment of attenuator probes, page 18
Abgleich der Spannungsteiler-Messköpfe, Seite 36
Réglage des sondes atténuatrices, page 54

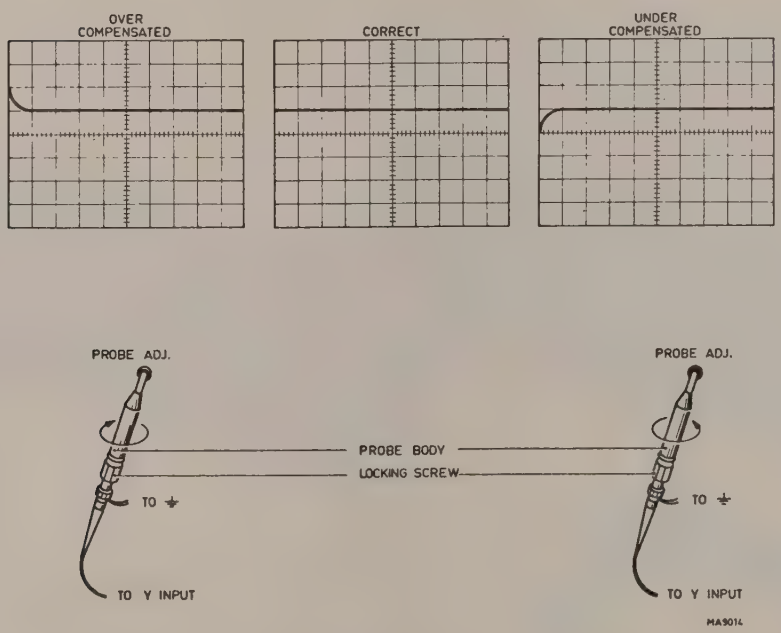


Fig. 3.15. Attenuator probe compensation

3.5.2 Attenuator probe sets PM 9336 and PM 9336L

The PM 9336 is a 10x attenuator probe, designed for oscilloscopes up to 25 MHz, having a BNC input jack and 10 to 35 pF input capacitance, paralleled by 1 MΩ. The PM 9336L is a similar probe with a cable length of 2.5 m.

The set consists of:

1 probe assembly	Fig. 3.16. item 1
5 soldering terminals	Fig. 3.16. item 2
1 test hook	Fig. 3.16. item 3
2 spare test hook sleeves	Fig. 3.16. item 4
1 protective cap	Fig. 3.16. item 5
1 probe holder	Fig. 3.16. item 6
2 probe tips	Fig. 3.16. item 7
1 earthing cord	Fig. 3.16. item 8
1 box	item 9

For ordering numbers of these parts, see list 3.6.4.2.

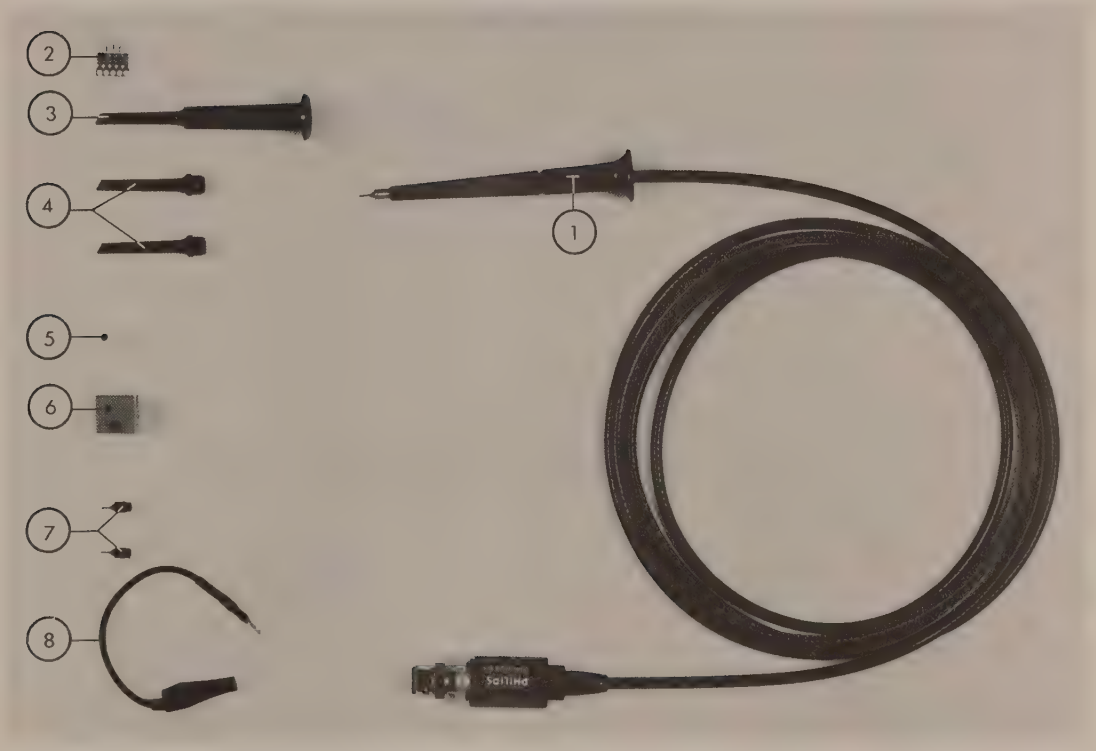


Fig. 3.16. Attenuator probe set PM 9336 (PM 9336L)

3.5.2.1 Technical data

Attenuation	1:10 ± 3%		
Input resistance	PM 9336	10 MOhm	± 2%
	PM 9336L	10 MOhm	± 2%
Input capacitance	PM 9336	11 pF	± 1 pF
	PM 9336L	14 pF	± 1 pF
Maximum allowable input voltage	500 V (D.C. + A.C. peak)		

3.5.2.2 Adjustment

The measuring probe has been adjusted and checked by the factory. However, to match the probe to your oscilloscope, the following manipulation is necessary.

Connect the measuring pin to socket PROBE ADJ of the oscilloscope.

A trimmer can be adjusted through a hole in the compensation box to obtain optimum square-wave response.

Note: For settings of the instrument controls, see Section 2.2.3:

Adjustment of attenuator probes, page 19
Abgleich der Spannungsteiler-Messköpfe, Seite 37
Réglage des sondes atténuatrices, page 55

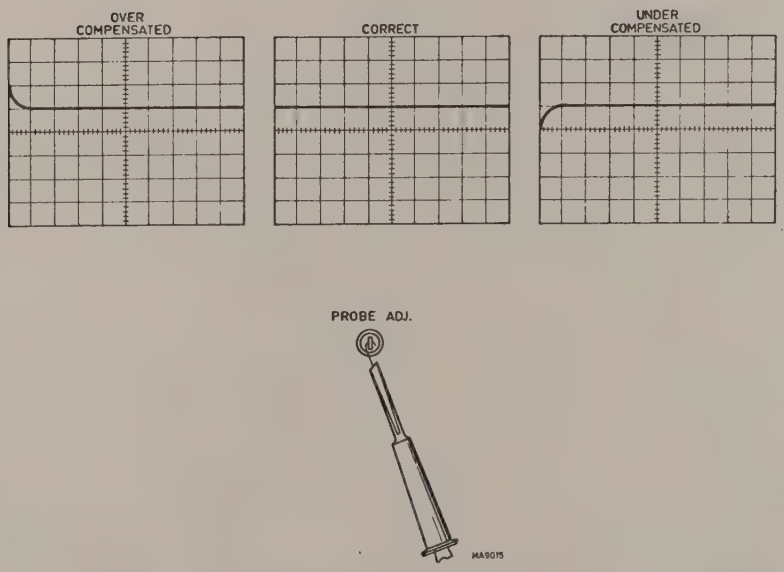


Fig. 3.17. Probe compensation

3.5.3 1:1 Probe sets PM 9335 and PM 9335L

The PM 9335 is a passive probe without signal attenuation for use with oscilloscope, counters and voltmeters having a high input impedance and a BNC input socket.
The cable design is such that the reflections due to the instrument's capacitive load are absorbed.
The useful range of this probe is restricted to d.c. and l.f. applications (up to 10 MHz).
The PM 9335L is a similar probe with a cable length of 2,5 m.

The set consists of:

1 test hook	Fig. 3.18. item 1
2 spare test hook sleeves	Fig. 3.18. item 2
2 spare probe tips	Fig. 3.18. item 3
1 protective cap	Fig. 3.18. item 4
1 earthing lead	Fig. 3.18. item 5
1 probe holder	Fig. 3.18. item 6
1 probe assembly	Fig. 3.18. item 7
1 box	item 8

For ordering numbers of these parts, see list 3.6.4.3.

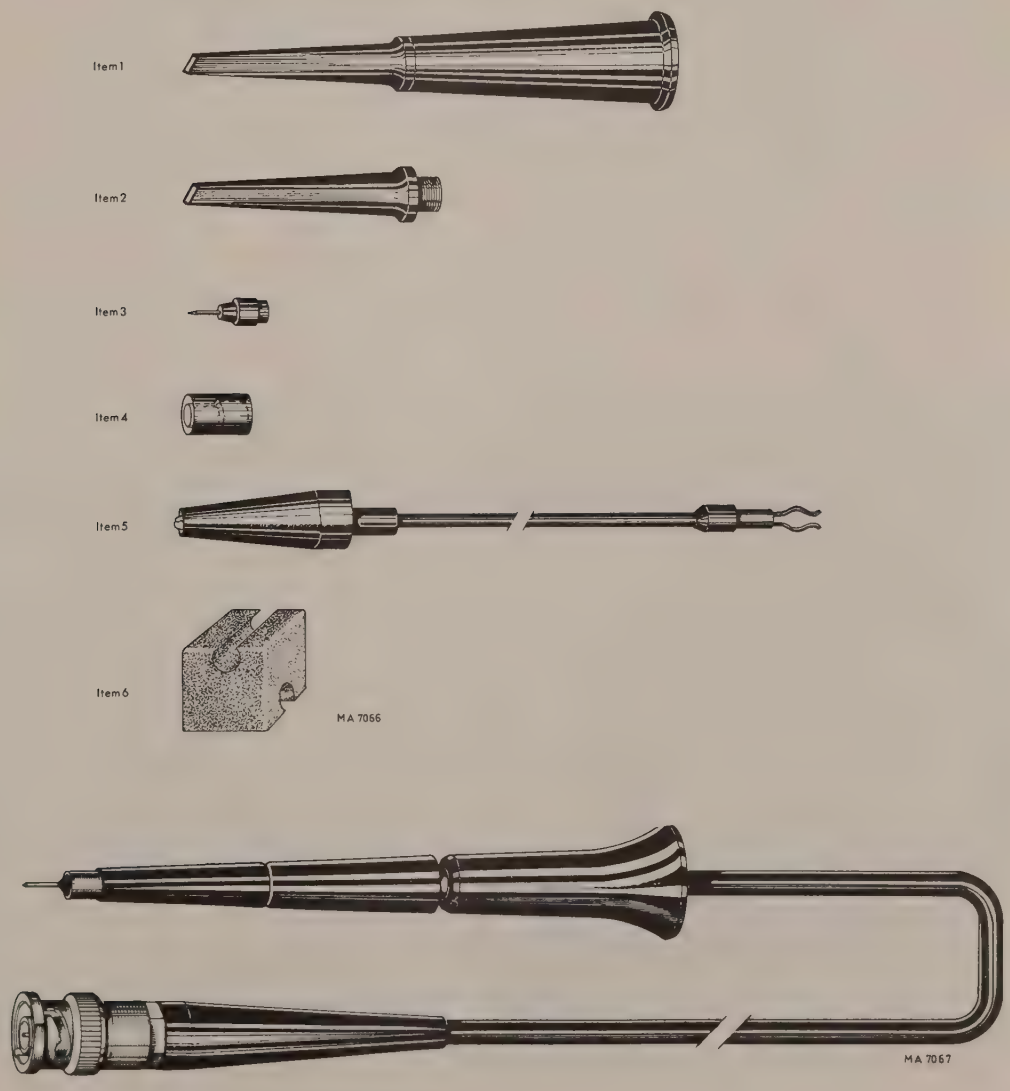


Fig. 3.18. Probe set PM 9335

3.5.3.1 Technical data

Attenuation	1:1
Input resistance	1 MOhm
Input capacitance	45 ± 5 pF + input cap. of measuring instrument

Max. allowable input voltage

D.C.	500 V
A.C. peak-to-peak	500 V derating at higher frequencies with $\frac{500\ V}{MHz}$
A.C. peak + D.C.	500 V

Dimensions	*L*	*W*	*H*
Probe body	105		mm
Cable	1.5		m
Box	230	104	24 mm

3.5.4 2 kV Attenuator set PM 9358

The PM 9358 is a 100x attenuator probe which can handle signals up to 2 kV $_{rms}$. The probe has been designed for use with oscilloscopes having a bandwidth up to 150 MHz, a BNC input jack and an input impedance of 1 MΩ paralleled by 10 to 30 pF.

The set consists of:

1 probe assembly	Fig. 3.19. item 1
5 soldering terminals	Fig. 3.19. item 2
1 test hook	Fig. 3.19. item 3
1 spare test hook sleeve	Fig. 3.19. item 4
1 protective cap	Fig. 3.19. item 5
1 insulating cap	Fig. 3.19. item 6
1 probe holder	Fig. 3.19. item 7
2 spare test pins	Fig. 3.19. item 8
1 earthing cord	Fig. 3.19. item 9
1 box	item 10

For ordering numbers of these parts, see list 3.6.4.4.

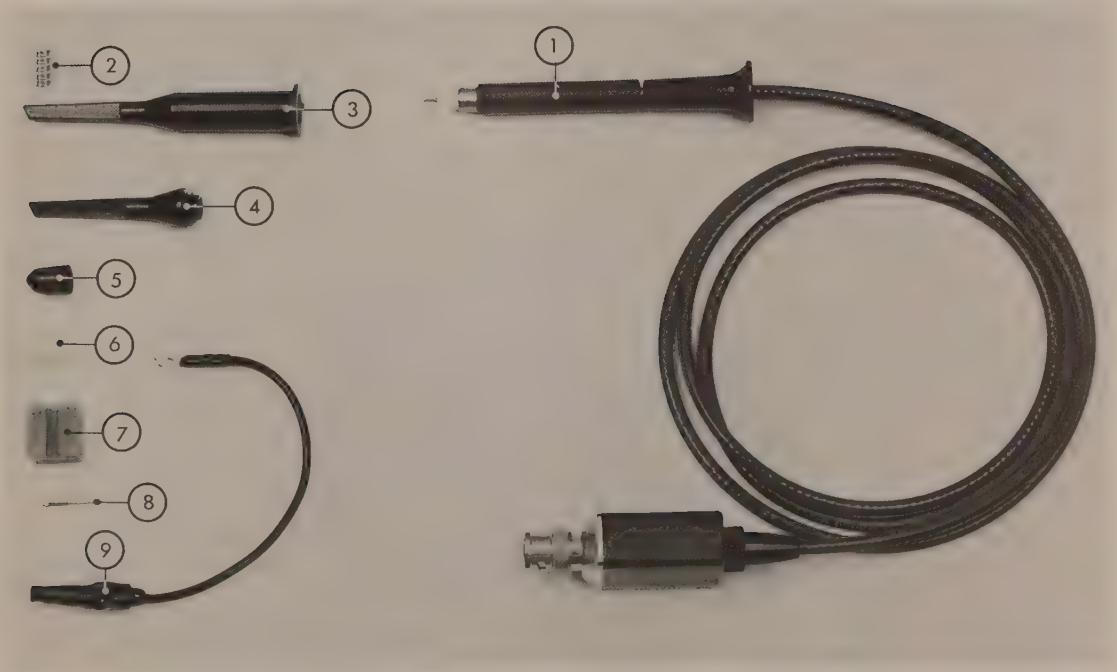


Fig. 3.19. Attenuator probe set PM 9358

3.5.4.1 Technical data

Attenuation		1:100 ± 2%
Input resistance		20 MOhm ± 3%
Input capacitance		2 pF ± 0.3 pF
Max. allowable voltage DC or AC_{rms}		
Continuous	2 kV	
Under pulsed conditions	2 kV	Duty cycle 50–100% dv/dt ⩽ 1000 V/ns Pulse rep. frequency ⩽ 1 MHz
	3 kV	Duty cycle 25–50% dv/dt ⩽ 500 V/ns Pulse rep. frequency ⩽ 1 MHz Max. pulse duration 100 ms
	4 kV	Duty cycle 0–25% dv/dt ⩽ 200 V/ns Pulse rep. frequency ⩽ 1 MHz Max. pulse duration 20 ms
Sinewaves continuous	5.6 kV_{p-p}	For frequencies up to 1 MHz

3.5.4.2 Adjustment

The measuring probe has been adjusted and checked by the factory. However, to match the probe to your oscilloscope, the following manipulation is necessary. Connect the measuring pin to socket PROBE ADJ of the oscilloscope. A trimmer can be adjusted through a hole in the compensation box to obtain optimum square-wave response.

See the following examples:

Note: For settings of the instrument controls, see Section 2.2.3.:

Adjustment of attenuator probes, page 19
Abgleich der Spannungsteiler-Messköpfe, Seite 37
Réglage des sondes atténuatrices, page 55

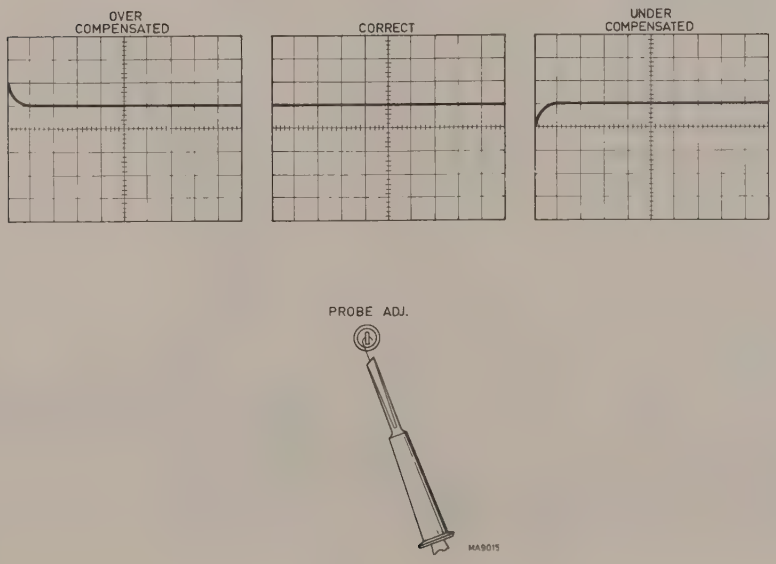


Fig. 3.20. Probe compensation

3.5.5 Multi-purpose camera PM 9380

Camera PM 9380 has been designed to photograph oscilloscope displays in a quick and simple way. It incorporates the Polaroid instant photographic process which has the advantage that you can see the picture a few moments after you took it.

Fig. 3. 21. Multi-purpose camera PM 9380

3.5.6 Adapter PM 8971

This adapter forms the connection between camera PM 9380 and oscilloscope PM 3225. The dimensions of the adapter are such, that the camera automatically focussed when the camera-adapter combination is held against the front of the oscilloscope.

Note: Cover the POWER ON lamp, when taking a photograph.

Fig. 3.22 Adapter PM 8971

3.5.7 Adapter PM 9051

This is an adapter to make a BNC socket suitable for the connection of two 4 mm banana plugs.

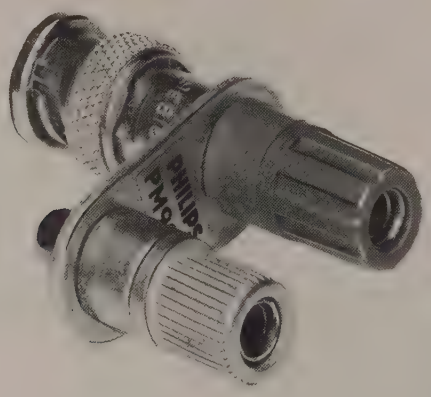


Fig. 3.23. Adapter PM 9051

3.5.8. Wrap pin adapter

This adapter is especially designed to connect a measuring probe to a wrapped wiring system. The adapter, which is pushed over the probe tip, can be used in wrapped systems with pins of up to 1 mm dia.

The wrap pin adapter fits the following (attenuator) probes: PM 9336 and PM 9336L
PM 9335 and PM 9335L
PM 9358

Ordering number 5322 264 24018.

Fig. 3.24. Wrap pin adapter

3.5.9. Anti-static spray (Type 815/ASS)

Anti-static 815/ASS is a special product for prevention of dust caused by static electricity. It can be used on all plastics and highly polished wooden surfaces. This spray gives a long-lasting protection against static charges and dust.

Application areas: — TV Screens — Masks — Picture Tubes
— Cabinets and Instrument Panels, etc.

Ordering number: 4822 390 80021 (English/Spanish text)
4822 389 50017 (Dutch/French text)
4822 389 50018 (German/Italian text)

Fig. 3 25. Anti-static spray

3.5.10. Trimming Tool Kit (Type 800/NTX)

This useful kit contains 3 twin-coloured holders, 2 extension holders and 21 interchangeable trimming pins. The wide variety of pins allows almost every type of trimming function to be carried out in instruments to be calibrated (e.g. measuring instruments, radio and T.V. sets).

Ordering number: 4822 310 50015.
(A spare set containing the 8 most commonly used pins is available under the Ordering number: 4822 310 50016.).

Fig. 3.26. Trimming tool kit

3.5.11 Dimensional drawing of a 19" rack adapter

This adapter makes the PM 3225 oscilloscope suitable for mounting in a 19" rack or cabinet.

Note: The dimensions are expressed in mm.

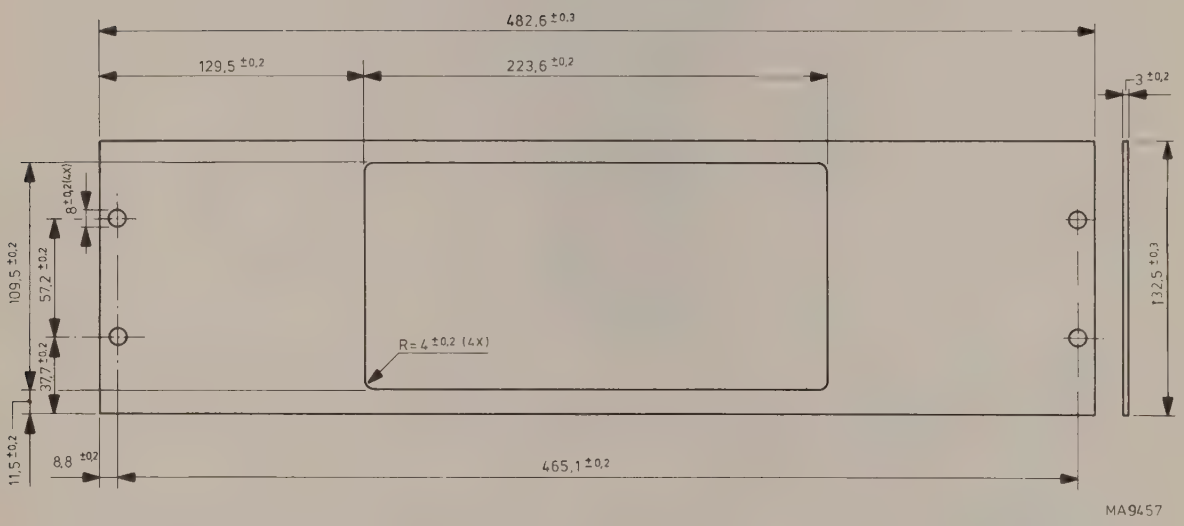


Fig. 3.27. Dimensioned sketch for 19" Rackmount PM 3225
Masszeichnung für 19" Gestelleinbau für PM 3225
Croquis coté pour montage en rack 19" du PM 3225

3.6 PARTS LISTS AND DIAGRAMS (Subject to alteration without notice)

3.6.1 Mechanical parts

Item	*Fig.*	*Qty.*	*Ordering number*	*Description*
1	3.28.	1	5322 460 64025	Cast-aluminium rear frame
2	3.28.	1	5322 447 94358	Cover (without carrying handle)
3	3.28.	1	5322 460 64024	Cast-aluminium front frame
4	3.28.	1	5322 451 34005	Bezel
5a	3.28.	1	5322 480 34084	Contrast filter (blue)
5b	3.28.	1	5322 480 34049	Contrast filter (grey)
6	3.28.	1	5322 480 34051	Graticule
7	3.28.	6	5322 414 34134	Control knob (R1, R2, R4, R5)
8	3.28.	6	5322 492 64337	Clamping spring (R1, R2, R4, R5)
9	3.28.	6	5322 414 74015	Cover for knob (R1, R2, R3, R4, R5)
10	3.28.	3	5322 414 34079	Switch knob
11	3.28.	3	5322 505 14228	Nut for switch knob
12	3.28.	2	5322 414 74019	Cover for switch knob
13	3.28.	1	5322 414 34091	Control knob
14	3.28.	1	5322 455 84055	Text plate
15	3.28.	1	5322 276 14117	Push-button switch (SK6, 7, 10, 11)
16	3.28.	3	5322 276 14101	Push-button switch (SK8, 9)
17	3.28.	9	5322 414 14011	Knob for push-button switch (grey)
18	3.28.	12	5322 414 25613	Knob for push-button switch (green-grey)
19	3.28.	3	5322 267 10004	BNC socket
20	3.28.	3	5322 506 14001	Nut for BNC socket
21	3.28.	1	5322 535 84346	Earthing terminal
22	3.28.	1	5322 505 14178	Knurled nut for earthing terminal
23	3.28.	1	5322 506 14005	Hexagonal nut for earthing terminal
24	3.28.	1	5322 264 24015	Calibration terminal
25	3.28.	1	5322 325 84013	Grommet for cal. terminal
26	3.28.	1	5322 255 44161	Holder for LED
27	3.28.	4	5322 462 44174	Foot (bottom side)
28	3.29.	2	5322 498 54048	Arm for carrying handle
29	3.29.	1	5322 498 54074	Carrying handle
30	3.29.	2	5322 520 34164	Bearing bush
31	3.29.	2	5322 528 34101	Ratchet
32	3.29.	2	5322 530 84075	Spring
33	3.29.	2	5322 414 64053	Knob
34	3.29.	4	5322 462 44176	Foot (rear side)
35	3.29.	1	5322 502 24525	Coin-slot screw
36	3.29.	1	4822 530 70124	Locking washer for item 35
37	3.29.	1	4822 272 10079	Voltage adaptor
38	3.29.	1	5322 321 14001	Mains cable
39	3.29.	1	5322 325 60119	Mains cable cleat
40	3.29.	1	5322 325 64068	Mains cable grommet

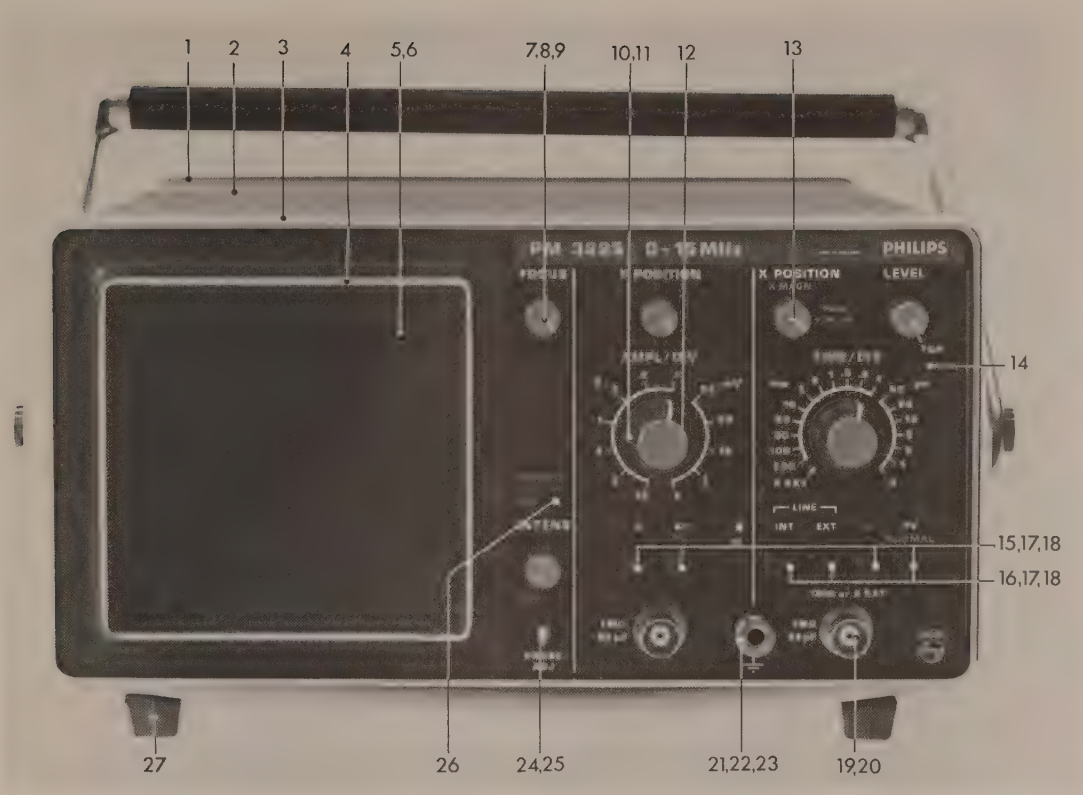


Fig. 3.28. Front view showing item numbers

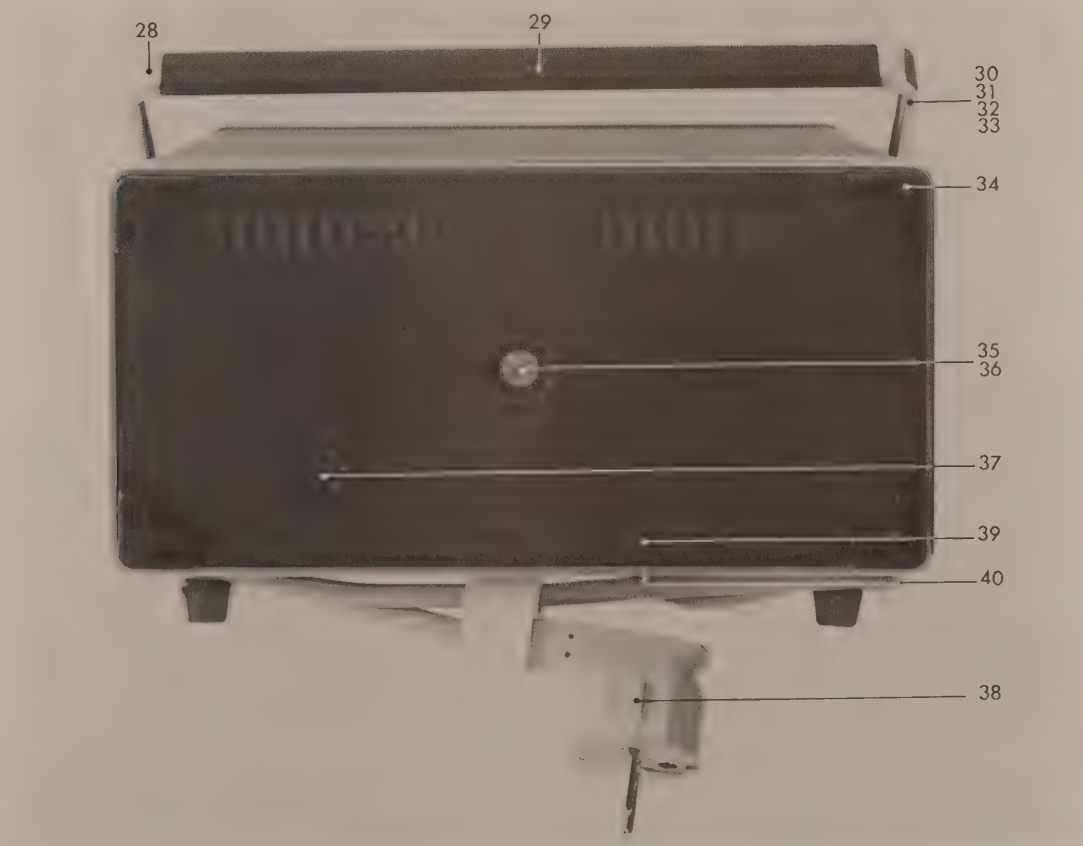


Fig. 3.29. Rear view showing item numbers

Item	Fig.	Qty.	Ordering number	Description
41	3.30.	1	5322 401 14166	Retaining brace for C.R.T.
42	3.30.	1	5322 532 64186	Rubber sleeve for C.R.T.
43	3.30.	1	5322 280 24047	Relay contact (RE 401)
44	3.30.	1	5322 158 14004	Coil 15 μH (L401)
45	3.30.	1	5322 256 94075	Nylon bracket for C.R.T.
46	3.30.	1	5322 405 94116	Clamp for item 45
47	3.30.	1	5322 255 70159	Valve socket for C.R.T.
48	3.30.	2	5322 405 94084	Nylon bracket for potentiometers (R1, R5)
49	3.30.	2	5322 535 74413	Nylon spindle for potentiometers (R1, R5)
50	3.30.	1	5322 447 94376	Transparent protective cover
51	3.30.	1	5322 146 44036	Mains transformer (T601)
52	3.30.	1	4822 252 20007	Thermal fuse
53	3.30.	1	5322 492 64591	Clip for thermal fuse
54	3.30.	2	5322 255 44129	Heat sink for transistors TS 613 and TS 614
55	3.30.	1	5322 216 54145	Vertical unit (p.c. board complete)
56	3.30.	1	5322 216 54146	Horizontal unit (p.c. board complete)
57	3.30.	1	5322 273 64044	Attenuator switch (without components)
58	3.30.	1	5322 273 64051	Time-base switch (without components)
59	3.30.	1	5322 105 34032	Time-base switch (with components)

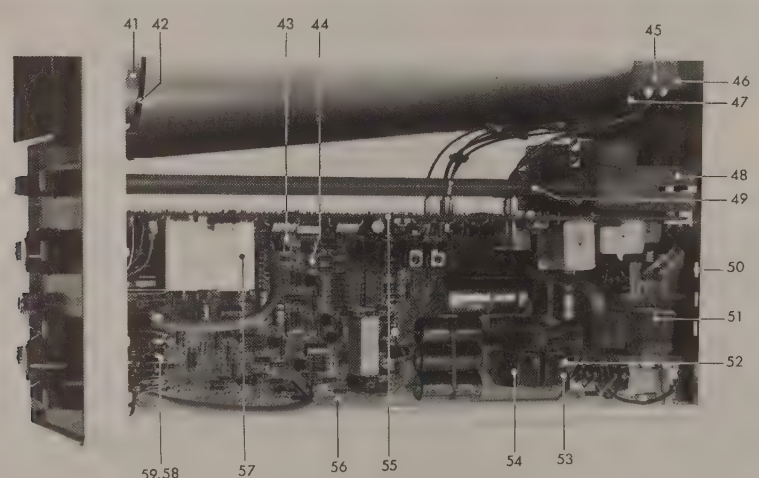


Fig. 3.30. Top view showing item numbers

3.6.2 Miscellaneous parts

Item	Ordering number	Type/Description
1	5322 447 94377	Protective front
2	5322 263 24005	Adapter (BNC-4 mm banana)
3a	5322 131 20022	C.R.T. D10-160 GH
3b	5322 131 20024	C.R.T. D10-160 GM
4	4822 130 30885	LED (Type CQY)
5	5322 255 44122	I.C. socket (5x)
6	5322 255 40089	Transistor socket (37x)
7	5322 255 44069	Transistor spacer (2x)
8	5322 255 44108	Transistor spacer (1x)
9	5322 255 44053	Transistor S-clip (TS 26)
10	4822 266 30071	3-pole plug (Stocko MKF 803-1-0-303)
11	4822 265 30121	3-pole socket (Stocko MKS 823-1-0-303)
12	4822 266 30072	4-pole plug (Stocko MKF 804-1-0-404)
13	4822 265 30119	4-pole socket (Stocko MKS 824-1-0-404)
14	4822 266 30073	6-pole plug (Stocko MKF 806-1-0-606)
15	4822 265 30117	6-pole socket (Stocko MKS 826-1-0-606)

3.6.3. Electrical parts

3.6.3.1. Capacitors

Item	Ordering number	Farad	Tol (%)	Volts	Remarks
C 26	4822 121 40145				POLYESTER FOIL
C 27	4822 122 31195	10PF	2	500	CERAMIC PLATE
C 28	5322 125 54026				TRIMMER
C 29	4822 122 31188	3,3PF	0,25PF	500	CERAMIC PLATE
C 31	5322 125 54026				TRIMMER
C 32	4822 122 31187	2,7PF	0,25PF	500	CERAMIC PLATE
C 33	5322 125 54026				TRIMMER
C 34	4822 122 31192	6,8PF	0,25PF	500	CERAMIC PLATE
C 36	5322 125 54026				TRIMMER
C 37	5322 125 54026				TRIMMER
C 38	5322 125 54026				TRIMMER
C 39	4822 122 31186	2,2PF	0,25PF	500	CERAMIC PLATE
C 41	4822 122 31201	27PF	2	500	CERAMIC PLATE
C 42	5322 125 54026				TRIMMER
C 43	5322 125 54026				TRIMMER
C 44	4822 122 31188	3,3PF	0,25PF	500	CERAMIC PLATE
C 46	4822 122 30113	180PF	2	100	CERAMIC PLATE
C 47	5322 125 54026				TRIMMER
C 48	5322 125 54026				TRIMMER
C 49	4822 122 31188	3,3PF	0,25PF	500	CERAMIC PLATE
C 51	5322 121 54148				POLYSTYRENE FOIL
C 52	4822 122 31199	22PF	2	500	CERAMIC PLATE
C 53	5322 125 54026				TRIMMER
C 54	4822 121 41161				POLYESTER FOIL
C 56	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 57	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 58	4822 121 40427				POLYESTER FOIL
C 62	4822 121 41161				POLYESTER FOIL
C 63	4822 125 50045				TRIMMER
C 64	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 65	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 66	4822 122 31213	0,68PF	0,25PF	500	CERAMIC PLATE
C 67	4822 122 31213	0,68PF	0,25PF	500	CERAMIC PLATE
C 68	4822 122 31213	0,68PF	0,25PF	500	CERAMIC PLATE
C 69	4822 122 31213	0,68PF	0,25PF	500	CERAMIC PLATE
C 71	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 72	4822 121 41161				POLYESTER FOIL
C 73	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 74	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 401	4822 122 31199	22PF	2	500	CERAMIC PLATE
C 402	4822 122 31222	220PF	2	100	CERAMIC PLATE
C 404	4822 121 40427				POLYESTER FOIL
C 405	4822 122 31061	18PF	2	100	CERAMIC PLATE
C 406	4822 124 20469	68UF	-10+50	16	ELECTROLYTIC
C 407	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 409	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 410	4822 122 31036	2,2PF	0,25PF	100	CERAMIC PLATE
C 411	4822 124 20476	22UF	-10+50	25	ELECTROLYTIC
C 412	4822 122 31036	2,2PF	0,25PF	100	CERAMIC PLATE
C 413	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 414	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 415	4822 122 31222	220PF	2	100	CERAMIC PLATE
C 416	4822 124 20583	1UF	-10+50	63	ELECTROLYTIC
C 417	4822 124 20453	68UF	-10+50	6,3	ELECTROLYTIC
C 418	4822 121 41161				POLYESTER FOIL
C 419	4822 122 30034	470PF	2	100	CERAMIC PLATE
C 420	5322 121 54153				TRIMMING POTM
C 421	5322 121 54153				TRIMMING POTM
C 422	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 423	4822 122 31067	33PF	2	100	CERAMIC PLATE
C 424	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 426	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE

Item	Ordering number	Farad	Tol (%)	Volts	Remarks
C 427	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 428	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 429	5322 121 40256				POLYESTER FOIL
C 430	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 431	4822 121 50415				POLYSTYRENE FOIL
C 432	4822 122 30027	1NF	-20+80	40	CERAMIC PLATE
C 433	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 434	4822 124 20605	1,5UF	-10+50	63	ELECTROLYTIC
C 435	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 436	4822 122 31175	1NF	10	100	CERAMIC PLATE
C 437	4822 124 20494	4,7UF	-10+50	63	ELECTROLYTIC
C 438	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 439	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 440	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 442	4822 124 20605	1,5UF	-10+50	63	ELECTROLYTIC
C 443	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 444	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 445	4822 122 31213	0,68PF	0,25PF	500	CERAMIC PLATE
C 446	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 447	4822 121 40427				POLYESTER FOIL
C 448	4822 121 41161				POLYESTER FOIL
C 449	4822 122 31213	0,68PF	0,25PF	500	CERAMIC PLATE
C 600	4822 121 41161				POLYESTER FOIL
C 601	4822 121 40407				POLYESTER FOIL
C 602	4822 121 40123				POLYESTER FOIL
C 603	4822 121 40178				POLYESTER FOIL
C 604	4822 121 40393				POLYESTER FOIL
C 605	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 606	4822 121 40178				POLYESTER FOIL
C 607	4822 121 40178				POLYESTER FOIL
C 608	4822 121 41161				POLYESTER FOIL
C 609	4822 121 40363				POLYESTER FOIL
C 610	4822 122 31069	39PF	2	100	CERAMIC PLATE
C 611	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 612	5322 124 24152	47UF		250	ELECTROLYTIC
C 613	5322 124 24153	220UF		100	ELECTROLYTIC
C 614	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 615	4822 121 40152				POLYESTER FOIL
C 616	4822 124 20523	680UF	-10+50	16	ELECTROLYTIC
C 617	4822 124 20582	47UF	-10+50	4	ELECTROLYTIC
C 618	4822 124 20523	680UF	-10+50	16	ELECTROLYTIC
C 619	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 620	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 621	4822 121 40407				POLYESTER FOIL
C 622	4822 124 20523	680UF	-10+50	16	ELECTROLYTIC
C 623	4822 121 40427				POLYESTER FOIL
C 624	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 625	4822 124 20469	68UF	-10+50	16	ELECTROLYTIC
C 626	4822 121 40196				POLYESTER FOIL

3.6.3.2. Resistors

Item	Ordering number	Ohm	Tol (%)	Type	Remarks
R 1	5322 101 24111	4,7M	20	0,25W	CARBON POTM LIN
R 2	5322 101 24073	4,7K	20	0,1W	CARBON POTM LIN
R 3	5322 101 64012	47K	20	0,1W	CARBON POTM LIN+SWITCH
R 4	5322 101 44019	47K	20	0,1W	CARBON POTM LIN+SWITCH
R 5	4822 101 40064	220K	20	0,25W	TRIMMING POTM
R 25	5322 116 54469	100	1	MR25	METAL FILM
R 26	5322 116 54619	10K	1	MR25	METAL FILM
R 27	5322 116 55161	604K	1	MR30	METAL FILM
R 28	5322 116 55162	665K	1	MR30	METAL FILM
R 29	5322 116 54323	800K	1	MR30	METAL FILM
R 30	5322 116 54469	100	1	MR25	METAL FILM
R 31	5322 116 54734	249K	1	MR25	METAL FILM
R 32	5322 116 54408	909K	1	MR30	METAL FILM
R 33	5322 116 54702	113K	1	MR25	METAL FILM
R 34	5322 116 54209	992K	1	MR30	METAL FILM
R 36	5322 116 54211	10,1K	1	MR30	METAL FILM
R 37	5322 116 54188	1M	1	MR30	METAL FILM
R 38	5322 116 54549	1K	1	MR25	METAL FILM
R 39	5322 116 55105	200K	1	MR30	METAL FILM
R 40	5322 116 50491	22,6	1	MR25	METAL FILM
R 41	5322 116 54323	800K	1	MR30	METAL FILM
R 42	5322 116 50568	4,99	1	MR25	METAL FILM
R 43	5322 116 50568	4,99	1	MR25	METAL FILM
R 44	5322 116 54627	13,3K	1	MR25	METAL FILM
R 45	5322 116 50491	22,6	1	MR25	METAL FILM
R 46	4822 100 10037	1K	20	0,05W	TRIMMING POTM
R 47	5322 116 50443	12,7K	1	MR25	METAL FILM
R 48	5322 116 50483	38,3K	1	MR25	METAL FILM
R 49	5322 116 54426	121	1	MR25	METAL FILM
R 51	5322 116 54716	162K	1	MR25	METAL FILM
R 52	5322 116 54643	20,5K	1	MR25	METAL FILM
R 53	5322 116 54643	20,5K	1	MR25	METAL FILM
R 54	5322 116 54576	2,37K	1	MR25	METAL FILM
R 57	5322 116 54571	1,96K	1	MR25	METAL FILM
R 58	5322 116 54571	1,96K	1	MR25	METAL FILM
R 59	5322 116 54431	16,2	1	MR25	METAL FILM
R 61	5322 116 54431	16,2	1	MR25	METAL FILM
R 62	5322 116 54536	750	1	MR25	METAL FILM
R 63	5322 116 54587	3,65K	1	MR25	METAL FILM
R 64	5322 116 54545	909	1	MR25	METAL FILM
R 66	5322 116 54587	3,65K	1	MR25	METAL FILM
R 67	5322 116 54536	750	1	MR25	METAL FILM
R 69	5322 116 54541	825	1	MR25	METAL FILM
R 71	5322 116 50766	147	1	MR25	METAL FILM
R 72	5322 116 54012	6,81K	1	MR25	METAL FILM
R 73	5322 116 54513	332	1	MR25	METAL FILM
R 74	4822 100 10038	470	20	0,05W	TRIMMING POTM
R 75	5322 116 54469	100	1	MR25	METAL FILM
R 76	5322 116 54012	6,81K	1	MR25	METAL FILM
R 77	5322 116 50581	2,49K	1	MR25	METAL FILM
R 78	5322 116 54009	562	1	MR25	METAL FILM
R 79	5322 116 54012	6,81K	1	MR25	METAL FILM
R 80	5322 116 54469	100	1	MR25	METAL FILM
R 81	5322 116 54012	6,81K	1	MR25	METAL FILM
R 82	5322 116 50679	237	1	MR25	METAL FILM
R 83	5322 116 54011	5,62K	1	MR25	METAL FILM
R 84	4822 116 20063				VDR
R 86	5322 116 54426	121	1	MR25	METAL FILM
R 87	5322 116 54011	5,62K	1	MR25	METAL FILM
R 88	5322 116 50557	46,4K	1	MR25	METAL FILM
R 89	5322 116 54545	909	1	MR25	METAL FILM
R 91	5322 116 50557	46,4K	1	MR25	METAL FILM
R 92	5322 116 54462	82,5	1	MR25	METAL FILM
R 93	5322 116 54011	5,62K	1	MR25	METAL FILM

Item	Ordering number	Ohm	Tol (%)	Type	Remarks
R 94	5322 116 54011	5,62K	1	MR25	METAL FILM
R 96	4822 116 20063				VDR
R 97	5322 116 54426	121	1	MR25	METAL FILM
R 98	5322 116 50679	237	1	MR25	METAL FILM
R 99	5322 116 54012	6,81K	1	MR25	METAL FILM
R 101	5322 116 54012	6,81K	1	MR25	METAL FILM
R 104	5322 116 50491	22,6	1	MR25	METAL FILM
R 105	5322 116 50491	22,6	1	MR25	METAL FILM
R 106	5322 116 50491	22,6	1	MR25	METAL FILM
R 401	5322 116 54408	909K	1	MR30	METAL FILM
R 402	5322 116 54442	51,1	1	MR25	METAL FILM
R 403	4822 110 63194	1,8M	10	CR25	CARBON
R 404	5322 116 54701	110K	1	MR25	METAL FILM
R 406	5322 116 54011	5,62K	1	MR25	METAL FILM
R 407	5322 116 54442	51,1	1	MR25	METAL FILM
R 408	5322 116 54696	100K	1	MR25	METAL FILM
R 409	5322 116 54504	274	1	MR25	METAL FILM
R 412	5322 116 54561	1,33K	1	MR25	METAL FILM
R 416	5322 116 54011	5,62K	1	MR25	METAL FILM
R 424	5322 116 54655	30,1K	1	MR25	METAL FILM
R 426	5322 116 54549	1K	1	MR25	METAL FILM
R 427	5322 116 54615	9,09K	1	MR25	METAL FILM
R 428	5322 116 54692	86,6K	1	MR25	METAL FILM
R 429	5322 116 54627	13,3K	1	MR25	METAL FILM
R 431	5322 116 54619	10K	1	MR25	METAL FILM
R 432	5322 116 54576	2,37K	1	MR25	METAL FILM
R 433	5322 116 54576	2,37K	1	MR25	METAL FILM
R 434	5322 116 50415	1,15K	1	MR25	METAL FILM
R 436	5322 116 54624	11,5K	1	MR25	METAL FILM
R 437	5322 116 50726	36,5K	1	MR25	METAL FILM
R 438	5322 116 54595	5,11K	1	MR25	METAL FILM
R 439	5322 116 50482	33,2K	1	MR25	METAL FILM
R 441	5322 116 50481	22,6K	1	MR25	METAL FILM
R 442	5322 116 54619	10K	1	MR25	METAL FILM
R 443	5322 116 54619	10K	1	MR25	METAL FILM
R 446	5322 116 54627	13,3K	1	MR25	METAL FILM
R 447	4822 110 60175	360K	5	CR25	TRIMMING POTM
R 448	5322 116 54442	51,1	1	MR25	METAL FILM
R 449	5322 116 54595	5,11K	1	MR25	METAL FILM
R 450	5322 116 54619	10K	1	MR25	METAL FILM
R 451	5322 116 54619	10K	1	MR25	METAL FILM
R 452	5322 116 50555	1,27K	1	MR25	METAL FILM
R 453	5322 116 54595	5,11K	1	MR25	METAL FILM
R 454	5322 116 54508	301	1	MR25	METAL FILM
R 456	5322 116 50669	205	1	MR25	METAL FILM
R 457	5322 116 54011	5,62K	1	MR25	METAL FILM
R 458	5322 116 50608	6,19K	1	MR25	METAL FILM
R 459	5322 116 50524	3,01K	1	MR25	METAL FILM
R 460	4822 100 10073	100	20	0,05W	TRIMMING POTM
R 461	5322 116 50524	3,01K	1	MR25	METAL FILM
R 462	5322 116 54011	5,62K	1	MR25	METAL FILM
R 463	5322 116 54627	13,3K	1	MR25	METAL FILM
R 464	5322 116 54558	8,25K	1	MR25	METAL FILM
R 466	5322 116 54011	5,62K	1	MR25	METAL FILM
R 467	5322 116 54627	13,3K	1	MR25	METAL FILM
R 468	5322 116 54558	8,25K	1	MR25	METAL FILM
* R 469	5322 116 54442	51,1E	1	MR25	
R 471	5322 116 50491	22,6	1	MR25	METAL FILM
R 472	5322 116 54426	121	1	MR25	METAL FILM
R 473	5322 116 54519	402	1	MR25	METAL FILM
R 474	5322 116 50579	3,16K	1	MR25	METAL FILM
R 476	5322 116 50593	16,2K	1	MR25	METAL FILM
R 477	5322 116 54442	51,1	1	MR25	METAL FILM
R 478	5322 116 54557	1,21K	1	MR25	METAL FILM
R 479	5322 116 54608	7,5K	1	MR25	METAL FILM
R 481	5322 116 54592	4,02K	1	MR25	METAL FILM
R 482	5322 116 50479	15,4K	1	MR25	METAL FILM

* From version /02:
R469 is replaced by L401, for ordering number see item 44 in list of chapter 3.6.1.

Item	Ordering Number	Ohm	Tol (%)	Type	Remarks
R 484	5322 116 50484	4,64K	1	MR25	METAL FILM
R 486	5322 116 54529	619	1	MR25	METAL FILM
R 487	5322 116 54565	1,62K	1	MR25	METAL FILM
R 488	5322 116 50664	2,05K	1	MR25	METAL FILM
R 489	5322 116 50581	2,49K	1	MR25	METAL FILM
R 491	5322 116 54619	10K	1	MR25	METAL FILM
R 492	5322 116 50672	51,1K	1	MR25	METAL FILM
R 493	5322 116 50669	205	1	MR25	METAL FILM
R 494	5322 116 54557	1,21K	1	MR25	METAL FILM
R 496	5322 116 54442	51,1	1	MR25	METAL FILM
R 497	5322 116 50731	10,5K	1	MR25	METAL FILM
R 498	5322 116 50482	33,2K	1	MR25	METAL FILM
R 499	5322 116 54469	100	1	MR25	METAL FILM
R 501	5322 116 54554	1,1K	1	MR25	METAL FILM
R 502	5322 116 54653	28,7K	1	MR25	METAL FILM
R 503	5322 116 54554	1,1K	1	MR25	METAL FILM
R 504	5322 116 50491	22,6	1	MR25	METAL FILM
R 505	5322 116 50664	2,05K	1	MR25	METAL FILM
R 506	4822 100 10025	4,7K	20	0,05W	TRIMMING POTM
R 507	5322 116 54627	13,3K	1	MR25	METAL FILM
R 508	4822 100 10027	2,2K	20	0,05W	TRIMMING POTM
R 509	5322 116 50664	2,05K	1	MR25	METAL FILM
R 510	5322 116 50452	10	1	MR25	METAL FILM
R 511	5322 116 54629	14K	1	MR25	METAL FILM
R 512	5322 116 54629	14K	1	MR25	METAL FILM
R 513	5322 116 54497	226	1	MR25	METAL FILM
R 514	5322 116 50527	33,2	1	MR25	METAL FILM
R 515	5322 116 50491	22,6	1	MR25	METAL FILM
R 516	5322 116 54011	5,62K	1	MR25	METAL FILM
R 517	5322 116 54627	13,3K	1	MR25	METAL FILM
R 518	5322 116 50559	27,4K	1	MR25	METAL FILM
R 519	5322 116 54655	30,1K	1	MR25	METAL FILM
R 520	5322 116 54623	11K	1	MR25	METAL FILM
R 521	5322 116 54623	11K	1	MR25	METAL FILM
R 522	4822 100 10023	470	20	0,05W	TRIMMING POTM
R 523	5322 116 50767	2,15K	1	MR25	METAL FILM
R 524	5322 116 50482	33,2K	1	MR25	METAL FILM
R 525	5322 116 54451	61,9	1	MR25	METAL FILM
R 526	5322 116 54615	9,09K	1	MR25	METAL FILM
R 527	5322 116 50509	4,87K	1	MR25	METAL FILM
R 528	5322 116 54552	1,05K	1	MR25	METAL FILM
R 529	5322 116 54442	51,1	1	MR25	METAL FILM
R 531	5322 116 50559	27,4K	1	MR25	METAL FILM
R 532	5322 116 50524	3,01K	1	MR25	METAL FILM
R 533	5322 116 54532	649	1	MR25	METAL FILM
R 534	5322 116 50635	1,47K	1	MR25	METAL FILM
R 536	5322 116 50635	1,47K	1	MR25	METAL FILM
R 537	5322 116 54619	10K	1	MR25	METAL FILM
R 538	5322 116 54442	51,1	1	MR25	METAL FILM
R 539	5322 116 50481	22,6K	1	MR25	METAL FILM
R 541	5322 116 50484	4,64K	1	MR25	METAL FILM
R 542	5322 116 54552	1,05K	1	MR25	METAL FILM
R 543	5322 116 50515	1,78K	1	MR25	METAL FILM
R 544	5322 116 54615	9,09K	1	MR25	METAL FILM
R 546	5322 116 54632	14,7K	1	MR25	METAL FILM
R 547	5322 116 54518	383	1	MR25	METAL FILM
R 548	5322 116 54689	82,5K	1	MR25	METAL FILM
R 549	5322 116 54689	82,5K	1	MR25	METAL FILM
R 551	5322 116 54009	562	1	MR25	METAL FILM
R 552	4822 116 20063				VDR
R 553	5322 116 50414	2,87K	1	MR25	METAL FILM
R 554	5322 116 50583	5,9K	1	MR25	METAL FILM
R 556	5322 116 54689	82,5K	1	MR25	METAL FILM
R 557	5322 116 54009	562	1	MR25	METAL FILM
R 558	4822 116 20063				VDR
R 559	5322 116 54689	82,5K	1	MR25	METAL FILM

Item	Ordering number	Ohm	Tol (%)	Type	Remarks
R 561	5322 116 54595	5,11K	1	MR25	METAL FILM
R 562	5322 116 54595	5,11K	1	MR25	METAL FILM
R 564	5322 116 50491	22,6	1	MR25	METAL FILM
R 566	5322 116 50524	3,01K	1	MR25	METAL FILM
R 581	5322 116 55163	787K	1	MR30	METAL FILM
R 582	5322 116 54339	392K	1	MR30	METAL FILM
R 583	5322 116 54725	196K	1	MR25	METAL FILM
R 584	5322 116 50533	78,7K	1	MR25	METAL FILM
R 586	5322 116 54664	39,2K	1	MR25	METAL FILM
R 587	5322 116 54641	19,6K	1	MR25	METAL FILM
R 588	5322 116 50458	7,87K	1	MR25	METAL FILM
R 589	5322 116 54589	3,83K	1	MR25	METAL FILM
R 591	5322 116 54569	1,91K	1	MR25	METAL FILM
R 600	5322 116 54192	5,11	1	MR25	METAL FILM
R 601	5322 116 54585	3,48K	1	MR25	METAL FILM
R 602	5322 116 50474	42,2K	1	MR25	METAL FILM
R 603	5322 116 54595	5,11K	1	MR25	METAL FILM
R 604	5322 116 50474	42,2K	1	MR25	METAL FILM
R 605	5322 116 54696	100K	1	MR25	METAL FILM
R 606	5322 116 50457	215	1	MR25	METAL FILM
R 607	4822 116 20063				VDR
R 608	5322 116 50515	1,78K	1	MR25	METAL FILM
R 609	5322 116 54619	10K	1	MR25	METAL FILM
R 611	4822 110 42223	22M	5	VR37	CARBON
R 612	4822 110 53107	1K	5	CR37	CARBON
R 613	4822 116 51098	100	5	PR37	METAL FILM
R 614	4822 100 10088	220K	20	0,05W	TRIMMING POTM
R 617	4822 110 60186	910K	5	CR25	CARBON
R 618	4822 110 63201	3,3M	10	CR25	CARBON
R 619	5322 116 64027	7,5M	5	VR37	METAL OXIDE
R 620	5322 116 54696	100K	1	MR25	METAL FILM
R 621	4822 100 10072	100K	20	0,05W	TRIMMING POTM
R 622	5322 116 54732	237K	1	MR25	METAL FILM
R 623	5322 116 54692	86,6K	1	MR25	METAL FILM
R 624	5322 116 50484	4,64K	1	MR25	METAL FILM
R 626	5322 116 54549	1K	1	MR25	METAL FILM
R 627	5322 116 50484	4,64K	1	MR25	METAL FILM
R 628	5322 116 50664	2,05K	1	MR25	METAL FILM
R 631	5322 116 54005	3,32K	1	MR25	METAL FILM
R 632	5322 116 54619	10K	1	MR25	METAL FILM
R 633	5322 116 50493	27,4	1	MR25	METAL FILM
R 634	5322 116 54558	8,25K	1	MR25	METAL FILM
R 636	5322 116 50572	12,1K	1	MR25	METAL FILM
R 637	4822 100 10027	2,2K	20	0,05W	TRIMMING POTM
R 638	5322 116 54558	8,25K	1	MR25	METAL FILM
R 639	5322 116 54558	8,25K	1	MR25	METAL FILM
R 640	5322 116 54549	1K	1	MR25	METAL FILM
R 642	5322 116 50493	27,4	1	MR25	METAL FILM
R 643	5322 116 54549	1K	1	MR25	METAL FILM
R 644	5322 116 50484	4,64K	1	MR25	METAL FILM
R 645	5322 116 54549	1K	1	MR25	METAL FILM
R 647	5322 116 54403	1K	5	PR52	METAL FILM
R 648	5322 116 54403	1K	5	PR52	METAL FILM
R 649	5322 116 54608	7,5K	1	MR25	METAL FILM
R 650	5322 116 54676	56,2K	1	MR25	METAL FILM
R 651	5322 116 54655	30,1K	1	MR25	METAL FILM
R 652	5322 116 54619	10K	1	MR25	METAL FILM
R 653	5322 116 54549	1K	1	MR25	METAL FILM

Item	Ordering number	Type/Description

3.6.3.3. Diodes

GR1	5322 130 34595	CQY24A-I
GR26	5322 130 34037	BAV45
GR401	5322 130 30613	BAW62
GR402	5322 130 30613	BAW62
GR406	5322 130 30613	BAW62
GR407	5322 130 30613	BAW62
GR408	5322 130 30613	BAW62
GR409	5322 130 30613	BAW62
GR411	5322 130 30613	BAW62
GR412	5322 130 30613	BAW62
GR413	5322 130 30613	BAW62
GR414	5322 130 30613	BAW62
GR416	5322 130 30229	AAZ15
GR417	5322 130 30613	BAW62
GR418	5322 130 30613	BAW62
GR419	5322 130 30613	BAW62
GR421	5322 130 30613	BAW62
GR422	5322 130 30613	BAW62
GR423	5322 130 30613	BAW62
GR424	5322 130 30613	BAW62
GR426	5322 130 30613	BAW62
GR427	5322 130 30613	BAW62
GR428	5322 130 30613	BAW62
GR429	5322 130 30613	BAW62
GR431	5322 130 30613	BAW62
GR432	5322 130 30613	BAW62
GR433	5322 130 30613	BAW62
GR434	5322 130 30613	BAW62
GR437	5322 130 30613	BAW62
GR438	5322 130 30613	BAW62
GR439	5322 130 30613	BAW62
GR441	5322 130 30613	BAW62
GR442	5322 130 30613	BAW62
GR443	5322 130 30613	BAW62
GR444	5322 130 30613	BAW62
GR446	5322 130 34173	BZX79-C5V6
GR447	5322 130 30613	BAW62
GR601	5322 130 34165	BZX79-C62
GR602	5322 130 34189	BAV20
GR603	5322 130 30668	BY184
GR604	5322 130 30668	BY184
GR606	5322 130 30668	BY184
GR607	5322 130 30668	BY184
GR608	5322 130 30613	BAW62
GR609	4822 130 30842	BAV21
GR611	5322 130 30195	BYX10
GR612	5322 130 30613	BAW62
GR613	5322 130 30521	BY179
GR617	5322 130 34048	BZX75-C2V8
GR618	4822 130 30842	BAV21
GR619	5322 130 30613	BAW62
GR621	5322 130 30613	BAW62
GR622	5322 130 30613	BAW62
GR624	5322 130 34173	BZX79-C5V6
GR626	5322 130 30414	BY164
GR627	5322 130 34297	BZX79-B10
GR628	5322 130 34049	BZX75-C2V1
GR631	5322 130 30613	BAW62
GR632	5322 130 30613	BAW62
GR633	5322 130 30521	BY179
GR638	5322 130 34048	BZX75-C2V8
GR639	5322 130 34165	BZX79-C62
GR641	5322 130 34139	BZX79-C56

Item	Ordering number	Type/Description

3.6.3.4. Transistors

*TS26	5322 130 44548	ON561
TS33	5322 130 44237	BF450
TS34	5322 130 44154	BF199
TS36	5322 130 44154	BF199
TS37	5322 130 44154	BF199
TS38	5322 130 44154	BF199
TS39	5322 130 44154	BF199
TS41	5322 130 44154	BF199
TS42	5322 130 44154	BF199
TS43	5322 130 44154	BF199
TS401	5322 130 44197	BC558B
TS402	5322 130 44197	BC558B
TS406	5322 130 44196	BC548C
TS407	5322 130 44196	BC548C
TS408	4822 130 40902	BF240
TS409	5322 130 44196	BC548C
TS411	5322 130 44256	BC557
TS412	5322 130 44197	BC558B
TS413	5322 130 40417	BSX20
TS414	5322 130 44196	BC548C
TS416	5322 130 44196	BC548C
TS417	5322 130 44196	BC548C
TS418	5322 130 44196	BC548C
TS419	5322 130 44197	BC558B
TS421	5322 130 44197	BC558B
TS422	5322 130 44197	BC558B
TS423	5322 130 44403	BF458
TS424	5322 130 44403	BF458
TS426	4822 130 40938	BC548
TS427	4822 130 40938	BC548
TS428	5322 130 44403	BF458
TS429	5322 130 44403	BF458
TS601	4822 130 40968	BSS38
TS602	4822 130 40968	BSS38
TS603	5322 130 44403	BF458
TS604	4822 130 40964	BC549
TS606	5322 130 44104	BC328
TS607	4822 130 40938	BC548
TS608	5322 130 44395	CNY43
TS609	4822 130 40938	BC548
TS611	4822 130 40941	BC558
TS612	5322 130 44121	BC338
TS613	5322 130 44389	BD263A
TS614	5322 130 44235	BD237
TS616	4822 130 40968	BSS38

*ON561 is a matched FET pair.

The ON561 pair can be replaced by matched FET pair BFW11,
Ordering number: 5322 130 44643

3.6.3.5. Integrated circuits

IC26	5322 209 84111	CA3086
IC27	5322 209 84862	SG3823N
IC401	5322 209 84111	CA3086
IC402	5322 209 84111	CA3086

3.6.4 Parts list of probe sets

3.6.4.1 Parts of attenuator probe sets PM 9326 and PM 9327 (Fig 3.15.)

Item	*Qty.*	*Ordering number*	*Description*
1	1	5322 320 10042	Probe cable 2 m for PM 9327
1	1	5322 321 20087	Probe cable 1.15 m for PM 9326
2	1	5322 321 20096	Earth lead 15 cm
3	1	5322 321 20134	Earth lead 30 cm
4	1	5322 266 20015	Measuring probe 1:1 (black)
5	1	5322 268 10029	Test pin
6	1	5322 268 10039	Test hook
7	1	5322 210 70044	Attenuator probe 1:10 (grey)
8	1	5322 264 20016	Test clip
	1	5322 111 20155	Resistor

3.6.4.2 Parts of attenuator probe sets PM 9336 and PM 9336L (Fig. 3.17.)

Item	*Qty.*	*Ordering code*	*Description*
1	1	5322 320 14004	Cable assembly PM 9336 (1,5 m)
1	1	5322 320 14013	Cable assembly PM 9336 (2,5 m)
2	1	5322 255 44026	Soldering terminal
3	1	5322 264 20024	Test hook
4	1	5322 264 20028	Test hook sleeve
5	1	5322 532 60535	Protective cap
6	1	5322 256 94034	Probe holder
7	1	5322 268 14017	Probe tip
8	1	5322 321 20223	Earthing cord
9	1	5322 600 34002	Box

3.6.4.3 Parts of probe set PM 9335 (Fig. 3.19.)

Item	*Qty.*	*Ordering code*	*Description*
1	1	5322 264 20024	Test-hook
2	1	5322 264 20028	Test-hook sleeve
3	1	5322 268 14017	Probe tip
4	1	5322 532 60535	Protective cap
5	1	5322 321 20223	Earth lead
6	1	5322 265 94034	Probe holder
7	1	5322 320 14005	Probe assembly
	1	5322 600 34002	Box

3.6.4.4 Parts of 2 k V probe set PM 9358 (Fig. 3.20.)

Item	*Qty.*	*Ordering number*	*Description*
1	1	5322 320 14004	Cable assembly
2	1	5322 255 44026	Soldering terminal
3	1	5322 264 24008	Test hook
4	1	5322 264 24009	Test hook sleeve
5	1	5322 462 74001	Protective cap
6	1	5322 462 54075	Insulating cap
7	1	5322 265 94034	Probe holder
8	1	5322 264 24011	Test pin
9	1	5322 321 20223	Earthing cord
	1	5322 600 14004	Box

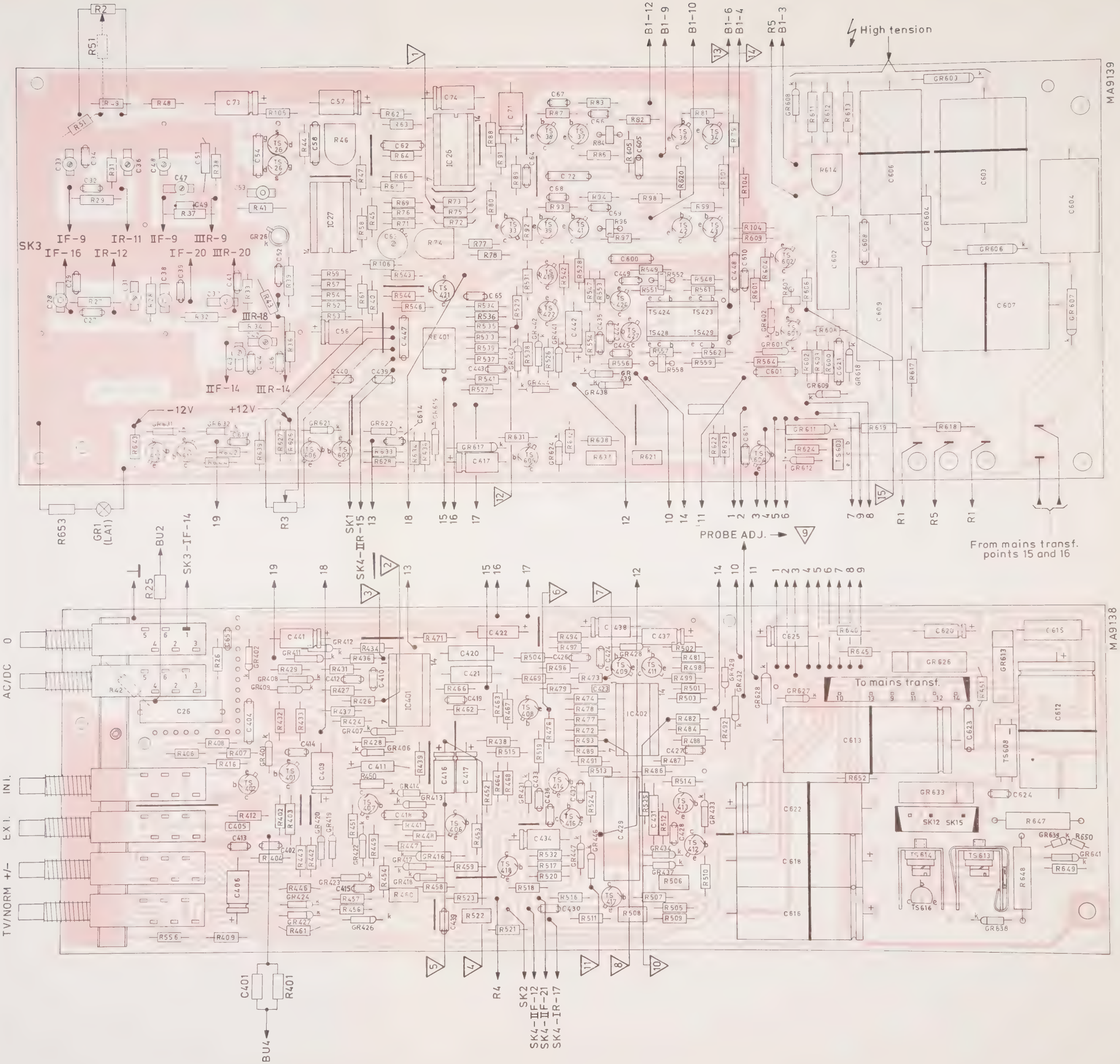


Fig. 3.33. Printed-wiring board (VERT)

Fig. 3.32. Printed-wiring board (HOR)

AMPL./DIV. (SK3)

SECTION I F

SECTION I R

SECTION II F

SECTION III R

BU2

BU3

AC/DC

Y-POSITION

AMPL./DIV. (SK3)

SECTION I II III

SECTION I

SECTION II

SECTION III

TIME./DIV (SK4)

SECTION I II

SECTION I

SECTION II

SK9 EXT

SK8 INT

SK10

LEVEL

SK2 TOP

SK11 TV/NORMAL

LINE

INT EXT

TV NORMAL

SK

AC DC

BU4

TRIG. OR X-EXT.

LINE

X-EXT.

PROBE ADJ.

BU1

X-EXT.

AC-O-DC SWITCH to 0

Y-POSITION at mid-range

+9V

switch O-AC-DC in position 0

+14V

+5V

+100A

+12V

-12V

-12A

+12A

-12D

+12C

+12B

D10-160GH

TOP VIEUW
CA 3086
SG 3823N

CNY 43

BF 199
BF 240
BF 450

ON561

BSS38
BC328
BC338
BC547
BC548
BC548C
BC557
BC558
BC558B

BF458
BF459
BD263A

BSX20

BAV45

BY164
BY179

BAV20
BAW62
BZX79

AAZ15
BZX75

BY 206

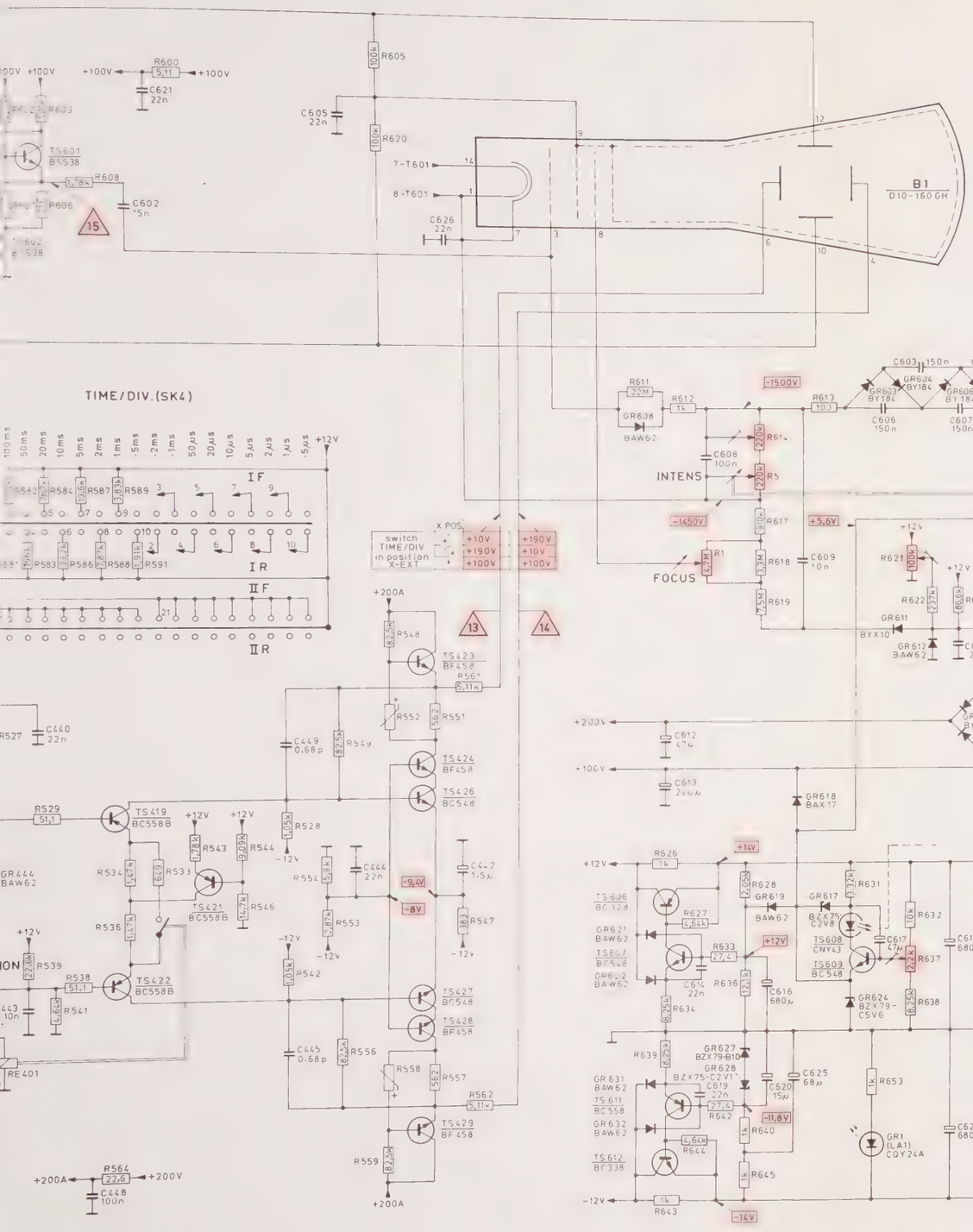
BAX17

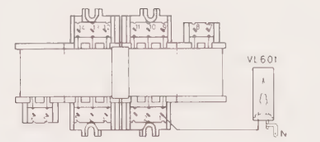
BY184
BYX10

Settings of the oscilloscope under test:

Y-POSITION at mid-range
X-POSITION at mid-range
LEVEL in Top position
AMPL/DIV at 1V/div
TIME/DIV at .5ms/div
INTERN, +, NORMAL
At input socket BU2
sinewave signal of
5Vp-p, 1kHz

Settings of the measuring oscilloscope:





Coil	S1	S1'a	S1'b	S2	S3a	S3b	S4a	S4b	S5
Connections	1-2	3-4	4-5	7-8	9-10	10-11	12-13	13-14	15-16
R20°C ± 10%	135Ω	118Ω	21Ω	6Ω	10Ω	10Ω	450Ω	450Ω	4117Ω
RMS (no load)	90V	90V	15V	8,5V	14V	14V	110V	110V	355V
Turns	1270	1270	212	120	196	196	1540	1540	5100
ø	0,14	0,14	0,14	0,2	0,2	0,2	0,09	0,09	0,05

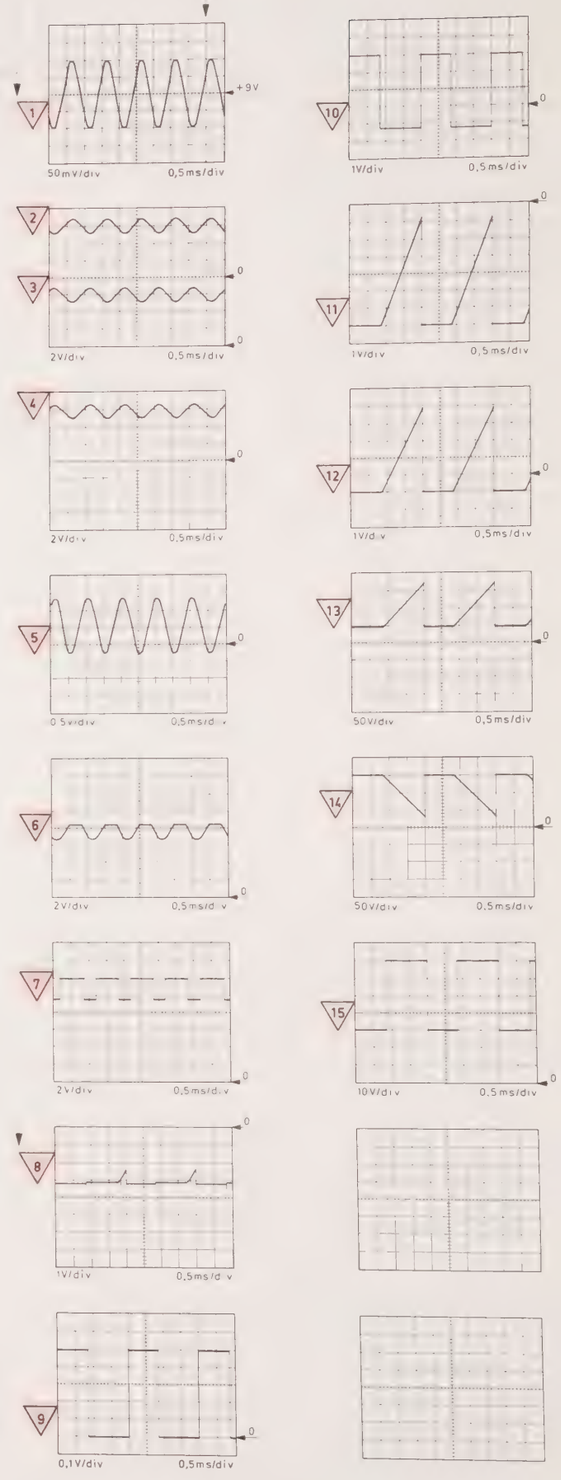


Fig. 3.34. Overall circuit diagram PM 3225

CODING SYSTEM OF FAILURE REPORTING FOR QUALITY ASSESSMENT OF T & M INSTRUMENTS
(excl. potentiometric recorders)

The information contents of the coded failure description is necessary for our computerized processing of quality data.

Since the reporting of repair and maintenance routines must be complete and exact, we give you an example of a correctly filled-out PHILIPS SERVICE Job sheet.

① Country	② Day Month Year	③ Typenumber /Version	④ Factory/Serial no.
32	150475	OPM 3260 02	DO 0078 3

CODED FAILURE DESCRIPTION ⑥

⑤ Nature of call	Location	Component/sequence no.	Category
☐ Installation		TS 0607	5
☐ Pre sale repair		R0 0631	2
☐ Preventive maintenance	0021	99 0001	4
☒ Corrective maintenance			
☐ Other			

⑦ *Job completed* ☒

Working time ⑧ 12 Hrs

Detailed description of the information to be entered in the various boxes:

①Country: 32 = Switzerland

②Day Month Year 150475 = 15 April 1975

③Type number/Version OPM 3260 02 = Oscilloscope PM 3260, version 02 (in later oscilloscopes this number is placed in front of the serial no)

④Factory/Serial number DO 0078 3 = DO 783 These data are mentioned on the type plate of the instrument

⑤ Nature of call: Enter a cross in the relevant box

⑥ Coded failure description

Location

☐☐☐☐

These four boxes are used to isolate the problem area. Write the code of the part in which the fault occurs, e.g. unit no or mechanical item no of this part (refer to 'PARTS LISTS' in the manual).

Example: 0001 for Unit 1
000A for Unit A
0075 for item 75

If units are not numbered, do not fill in the four boxes; see Example Job sheet.

Component/sequence no.

☐☐☐☐☐☐

These six boxes are intended to pinpoint the faulty component.

A. Enter the component designation as used in the circuit diagram. If the designation is alfa-numeric, the letters must be written (starting from the left) in the two left-hand boxes and the figures must be written (in such a way that the last digit occupies the right-most box) in the four right-hand boxes.

B. Parts not identified in the circuit diagram:

990000 Unknown/Not applicable
990001 Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.)
990002 Knob (incl. dial knob, cap, etc.)
990003 Probe (only if attached to instrument)
990004 Leads and associated plugs
990005 Holder (valve, transistor, fuse, board, etc.)
990006 Complete unit (p.w. board, h.t. unit, etc.)
990007 Accessory (only those without type number)
990008 Documentation (manual, supplement, etc.)
990009 Foreign object
990099 Miscellaneous

Category

☐

0 Unknown, not applicable (fault not present, intermittent or disappeared)
1 Software error
2 Readjustment
3 Electrical repair (wiring, solder joint, etc.)
4 Mechanical repair (polishing, filing, remachining, etc.)
5 Replacement (of transistor, resistor, etc.)
6 Cleaning and/or lubrication
7 Operator error
8 Missing items (on pre-sale test)
9 Environmental requirements are not met

⑦ Job completed: Enter a cross when the job has been completed.

⑧ Working time: Enter the total number of working hours spent in connection with the job (excluding travelling, waiting time, etc.), using the last box for tenths of hours.

☐☐12 = 1,2 working hours (1 h 12 min.)

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